SUS
376

# Workshop #5 - Water Quality

I. Introduction

II. Pre-project Susitna River Water Quality

A. Drainage Basin Morphology

B. Physical and Chemical Characteristics of the Susitna

C. Inorganic Entities

D. Organic Entities

E. Metals, Pesticides

F. Miscellaneous

G. Gas Supersaturation

DISCUSSION

III. Dam Designs and Operations

A. Watana Dam

1. Basic Design

a. Hydraulic Features
b. Hydraulic Operations

2. Mid-level Outlet Works

a. Detailed Design
b. Detailed Operation

B. Devil Canyon Dam

1. Basic Design

a. Hydraulic Features
b. Hydraulic Operations

2. Mid-level Outlet Works

a. Detailed Design
b. Detailed Operations

C. Avoidance of Gas Supersaturation by Mechanical Designs and Discharge Operations

1. Annual Hydrographs

2. Spilling Discharges

C (continued)

3. Floods - Handled Without Spillways for up to 1 in 50 year flood event

DISCUSSION

IV. Limnological Characteristics of Reservoir

A. Morphological and Hydrological Features of Reservoirs

1. Watana

2. Devil Canyon

B. Reservoir Valley

C. Riverine Inflow

1. Overflow,Underflows and Interflows

2. Photographic Examples

D. Key Limnological Factors Contributing to Reservoir Water Quality

E. Some Estimated Limnological Characteristics and Trophic Status of reservoirs

F. Comparison to Other Glacial Lakes of South Central Alaska

G. Brief Discussion of Potential for Reservoir Fishery

DISCUSSION

Lunch Break - 1 hr. 15 min.

1:30 P.M.

V. Estimated Trends in Downstream Water Quality With-project vs. Pre-project.

A. Estimated Changes in Downstream Nutrients and Primary Productivity

1. Factors Affecting Primary Productivity

2. Summary of Expectations

DISCUSSION

B. Estimated Changes in Total Suspended Sediments and Turbidity

1. Pre - project TSS and Turbidity in Susitna River

2. Eklutna Lake Studies

3. Current Estimates for With - project TSS

4. Future Study Efforts Planned to Refine Estimates of TSS and Turbidity

5. Minerology of TSS in Glacial Lakes

6. Preliminary Estimates of Turbidity vs. TSS Relationships

7. Preliminary Estimates of Turbidity vs. Euphotic Zone Depth

8. Preliminary Estimates of Fisheries vs. Chronic Exposure to Glacial Flour

DISCUSSION

C. Estimated Potential for Project-induced Mercury Bioaccumulation

1. Chemistry

2. Bioaccumulation Mechanism

3. Summary of Expectations for Susitna

4. Future Plans for Study

DISCUSSION

VI. Brief Discussion of Coordination with State and Federal Agencies

1. Permits Required

2. Best Practices Management Manuals

DISCUSSION

VII. "Open Forum": Question and Answer Session on Water Quality Topics

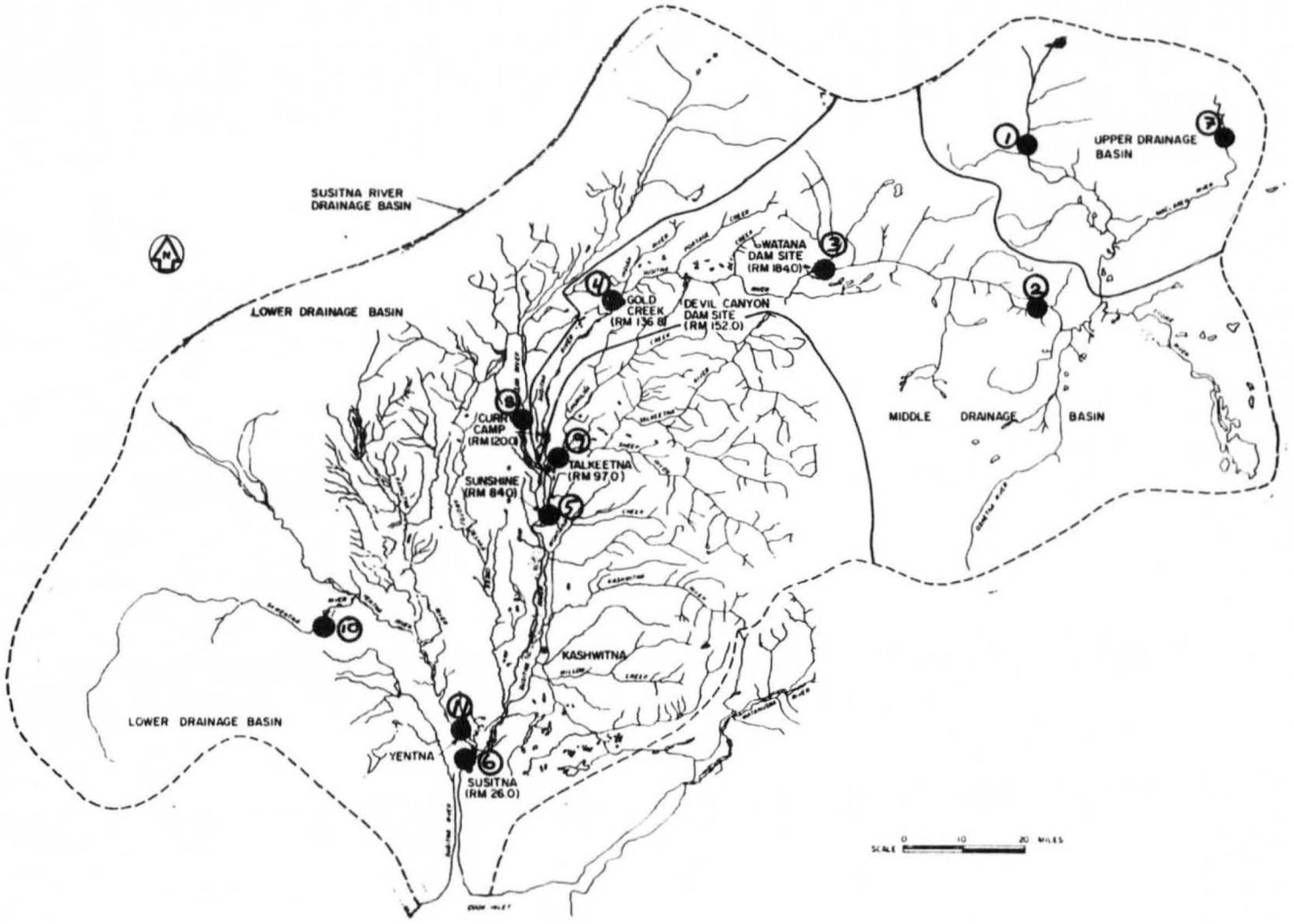
## TABLE E.2.2: PERIODS OF RECORD FOR GAGING STATIONS

| Station Name | USGS Gage Number | Susitna River Mile | Drainage Area ($mi^2$) | Periods of Record | | Agency |
|---|---|---|---|---|---|---|
| | | | | Streamflow (Continuous)[1] | Water Quality[2] | |
| Susitna River nr. Denali | 15291000 | 290.8 | 950 | 5/57-9/66, 11/68-Present | 1957-66, 1968-69, 1974-Present (6/30/82) | USGS |
| Susitna River nr. Cantwell (Vee Canyon) | 15291500 | 223.1 | 4,140 | 5/61-9/72, 5/80-Present | 1962-72, 1980-Present(7/27/82) | USGS |
| Susitna River nr. Cantwell (Vee Canyon) | - | 223.1 | 4,140 | - | 1980-81 | R&M Consult. |
| Susitna River nr. Watana Damsite | - | 182.2[3] | 5,180 | 6/80-Present | 10/80-12/81 | R&M Consult. |
| Susitna River at Gold Creek | 15292000 | 136.6 | 6,160 | 8/49-Present | 1949-58, 1962, 1967-68, 1974-Present (9/16/82) | USGS |
| Susitna River at Gold Creek | - | 136.6 | 6,160 | - | 1980-Present(10/14/82) | R&M |
| Susitna River at Sunshine | 15292780 | 83.9 | 11,100 | 5/81-Present | 1971, 1975, 1977, 1981-Present (10/13/82) | |
| Susitna River at Susitna Station | 15294350 | 25.8 | 19,400 | 10/74-Present | 1955, 1970, 1975-Present(10/5/82) | USGS |
| Maclaren River nr. Paxson | 15291200 | 259.8[4] | 280 | 6/58-Present | 1958-61, 1967-68, 1975 | USGS |
| Chulitna River nr. Talkeetna | 15292400 | 98.0[4] | 2,570 | 2/58-9/72, 5/80-Present | 1958-59, 1967-72, 1980-Present (6/3/82) | USGS |
| Talkeetna River nr. Talkeetna | 15291500 | 97.0[4] | 2,006 | 6/64-Present | 1954, 1966-Present(10/14/82) | USGS |
| Skwentna River nr. Skwentna | 15294300 | 28.0[5] | 2,250 | 10/59-Present | 1959, 1961, 1967-68, 1974-75, 1980-81 | USGS |
| Yentna River nr. Susitna Station | 15294345 | 28.0[4] | 6,180 | 10/80-Present | 1981-Present (8/11/82) | USGS |

Notes:

1. All streamflow gage stations are currently active, however, flow data included in this document is through September 1981.
2. "Present" in periods of record indicates station is active as of January 1983. A date after "Present" indicates the most recent data available.
3. Watana continuous water quality monitor was installed at river mile 183.0.
4. River mile at tributary's confluence with Susitna River.
5. River mile at Yentna-Susitna confluence.

Source: USGS and R&M




SUSITNA RIVER DRAINAGE BASIN

FIGURE E-14

TABLE E.2.16: DETECTION LIMITS AND CRITERIA FOR WATER QUALITY PARAMETERS

| Parameters[1] | R&M Detection Limit | USGS Detection Limit[4] | Criteria Levels |
|---|---|---|---|
| Temperature, °C | 0.1 | -- | 20,15(M),13(Sp) |
| Total Suspended Sediments[2] | 1 | 1 | no measurable increase |
| Turbidity (NTU) | 0.05 | 1 | 25 NTU increase |
| Dissolved Oxygen | 0.1 | -- | 7 and 17 |
| D.O. Percent Saturation | 1 | -- | 110 |
| Nitrate Nitrogen | 0.1 | 0.01 | 10 |
| Total Phosphorus | 0.01 | 0.01 | 0.01 |
| Ortho-Phosphate | 0.01 | 0.01 | -- |
| Total Dissolved Solids[3] | 1 | 1 | 1,500 |
| Conductivity, umhos/cm @ 25°C | 1 | -- | -- |
| **Significant Ions** | | | |
| Sulfate | 1 | 0.05 | 200 |
| Chloride | 0.2 | 0.01 | 200 |
| Ca, Calcium | 0.05 | 0.01 | -- |
| Mg, Magnesium | 0.05 | 0.1 | -- |
| Na, Sodium | 0.05 | 0.1 | -- |
| K, Potassium | 0.05 | 0.1 | -- |
| Total Hardness | 1 | -- | -- |
| pH, pH Units | ± 0.01 | -- | 6.5 - 9.0 |
| Total Alkalinity, as $CaCO_3$ | 2 | -- | 20 |
| Free Carbon Dioxide | 1 | -- | -- |
| Chemical Oxygen Demand | 1 | -- | -- |
| Total Organic Carbon | 1.0 | -- | 3.0 (S) |
| True Color, Platinum Cobalt Units | 1 | 1 | 50 |
| **Metals** | | | |
| Ag, Silver | 0.05 | 0.001 | 0.05 |
| Al, Aluminum | 0.05 | 0.01 | 0.073 (S) |
| As, Arsenic | 0.10 | 0.001 | 0.440 |
| Au, Gold | 0.05 | -- | -- |
| B, Boron | 0.05 | 0.01 | 0.043 |
| Ba, Barium | 0.05 | 0.1 | 1.0 |
| Bi, Bismuth | 0.05 | -- | 0.0035 (S) |
| Cd, Cadmium | 0.01 | 0.001 | 0.0012, 0.0004 |
| Co, Cobalt | 0.05 | 0.001 | -- |
| Cr, Chromium | 0.05 | 0.001 | 0.1 |
| Cu, Copper | 0.05 | 0.001 | 0.01 |
| Fe, Iron | 0.05 | 0.01 | 1.0 |
| Hg, Mercury | 0.1 | 0.0001 | 0.00005 |
| Mn, Manganese | 0.05 | 0.001 | 0.05 |
| Mo, Molybdenum | 0.05 | 0.001 | 0.07 |
| Ni, Nickel | 0.05 | 0.001 | 0.025 |
| Pb, Lead | 0.05 | 0.001 | 0.03 |
| Pt, Platinum | 0.05 | -- | -- |
| Sb, Antimony | 0.10 | 0.001 | 9 |
| Se, Selenium | 0.10 | 0.001 | 0.01 |
| Si, Silicon | 0.05 | -- | -- |
| Sn, Tin | 0.10 | 0.1 | -- |
| Sr, Strontium | 0.05 | 0.01 | -- |
| Ti, Titanium | 0.05 | -- | -- |
| W, Tungsten | 1.0 | -- | -- |
| V, Vanadium | 0.05 | -- | 0.007 (S) |
| Zn, Zinc | 0.05 | 0.01 | 0.03 |
| Zr, Zirconium | 0.05 | -- | -- |
| **Organic Chemicals** (ug/l) | | | |
| - Endrin | 0.0002 | 0.00001 | 0.004 |
| - Lindane | 0.004 | 0.00001 | 0.01 |
| - Methoxychlor | 0.1 | 0.00001 | 0.03 |
| - Toxaphene | 0.005 | 0.001 | 0.013 |
| - 2, 4-D | 0.1 | 0.00001 | 100 |
| - 2, 4, 5-TP Silvex | 0.01 | 0.00001 | 10 |
| Gross Alpha (Picocurie/liter) | 3 | -- | 15 |

TABLE E.2.16 (Cont'd)

| Parameters[1] | R&M Detection Limit | USGS Detection Limit[4] | Criteria Levels |
|---|---|---|---|
| Others | | | |
| Settleable Solids, ml/l | 0.1 | --- | -- |
| Ammonia Nitrogen | 0.05 | 0.01 | 0.02 |
| Organic Nitrogen | 0.1 | -- | -- |
| Kheldahl Nitrogen | 0.1 | 0.1 | -- |
| Nitrite Nitrogen | 0.01 | 0.01 | -- |
| Total Nitrogen | 0.1 | 0.01 | -- |
| Total Inorganic Carbon | 1.0 | -- | -- |

(1) All parameters and values are expressed in mg/l unless otherwise noted.

(2) TSS - (nonfilterable) material on a standard fiber filter after filtration of a well-mixed sample.

(3) TDS - (filterable) material that passes through a standard glass fiber filter and remains after evaporation.

(4) USGS detection limits are taken from "1982 Water Quality Laboratory Services Catalog" USGS Open-File Report 81-1016. The limits used are the limits for the most precise test available.

(M) - Migration Routes

(Sp) - Spawning Areas

(S) - Suggested Criteria

Source: USGS and RM

TABLE E.2.17: PARAMETERS EXCEEDING CRITERIA BY STATION AND SEASON

| Parameter | Station | Season | Criteria |
|---|---|---|---|
| D.O. % Saturation | G | S | L |
| Phosphorus, Total (d) | V, G, T, S, SS | S, W, B | E |
| pH | T | S | L |
| | V, S | W | |
| | G, T | B | |
| Total Organic Carbon | G, SS | S | S |
| | V, G, SS | W | |
| | SS | B | |
| True Color | V, G, T, S | S | L |
| Aluminum (d) | V, G | S, W | S |
| Aluminum (t) | G, T, S | S | S |
| Bismuth (d) | V, G | S | S |
| | G | W | |
| Cadmium (d) | G, T, SS | S | E |
| Cadmium (t) | G, T, S, SS | S | E |
| | T, SS | W | |
| Copper (d) | SS | S | A |
| | T | W | |
| | T, SS | B | |
| Copper (t) | G, T, S, SS | S | A |
| | T, SS | W, B | |
| Iron (t) | G, T, S, SS | S | E |
| | T, SS | B | |
| Lead (t) | G, T, S, SS | S | A |
| | SS | B | |
| Manganese (d) | G, | S | E |
| Manganese (t) | G, T, S, SS | S | E |
| | T, SS | B | |
| Mercury (d) | G, T, S, SS | S | E |
| | T, S | W | |
| Mercury (t) | G, T, S, SS | S | E |
| | T, S, SS | W | |
| | T, SS | B | |
| Nickel (t) | G, S, SS | S | A |
| Zinc (d) | S | W | A |
| | T | B | |
| Zinc (t) | G, T, S, SS | S | A |
| | T, SS | W, B | |

Notes:

Parameter
(d) dissolved
(t) total recoverable

Stations
D - Denali
V - Vee Canyon
G - Gold Creek
C - Chulitna
T - Talkeetna
S - Sunshine
SS - Susitna Station

Seasons
S - Summer
W - Winter
B - Breakup

Criteria
L - Established by law as per Alaska Water Quality Standards, 1979.
E - Established by law as per EPA Quality Criteria for Water, 1976.
S - Criteria that have been suggested but are not law, or levels which natural waters usually do not exceed.
A - Alternate level to 0.01 of the 96-hour $LC_{50}$ determined through bioassay (EPA 1976).

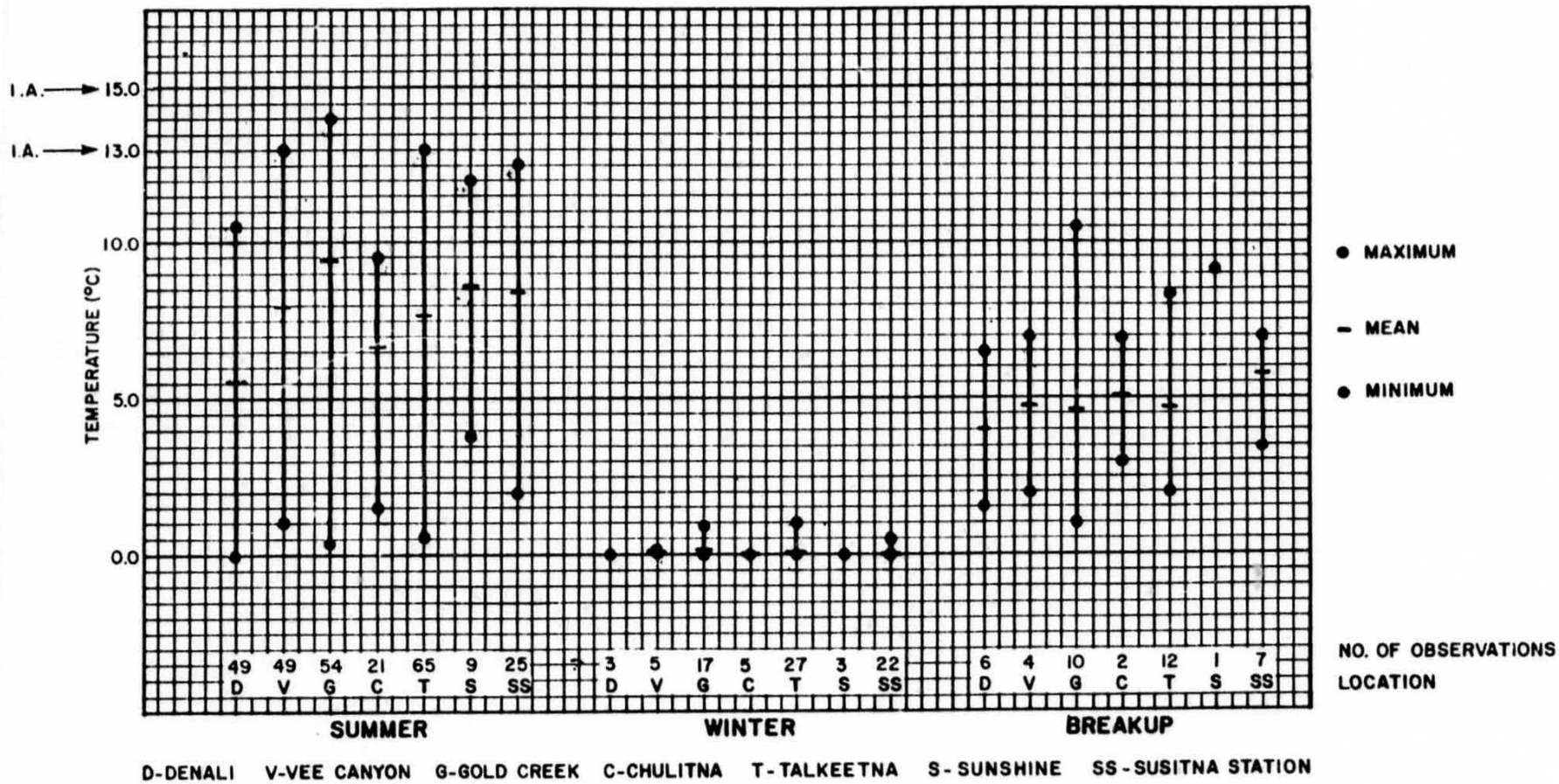
Source: USGS AND R&M

## SEASON DEFINITIONS FOR WATER QUALITY SUMMARY

Breakup - from the time ice begins to break up until recession of spring runoff.

Summer - from the end of breakup until the water temperature drops to essentially $0^{\circ}$ C in the fall.

Winter - from the end of summer until breakup begins.




NOTES:

I. A. CRITERIA: SHALL NOT EXCEED 20°C AT ANY TIME. THE FOLLOWING MAXIMUM TEMPERATURE SHALL NOT BE EXCEEDED WHERE APPLICABLE: MIGRATION ROUTES AND REARING AREAS--15°C, SPAWNING AREAS AND EGG AND FRY INCUBATION--13°C (ADEC, 1979).

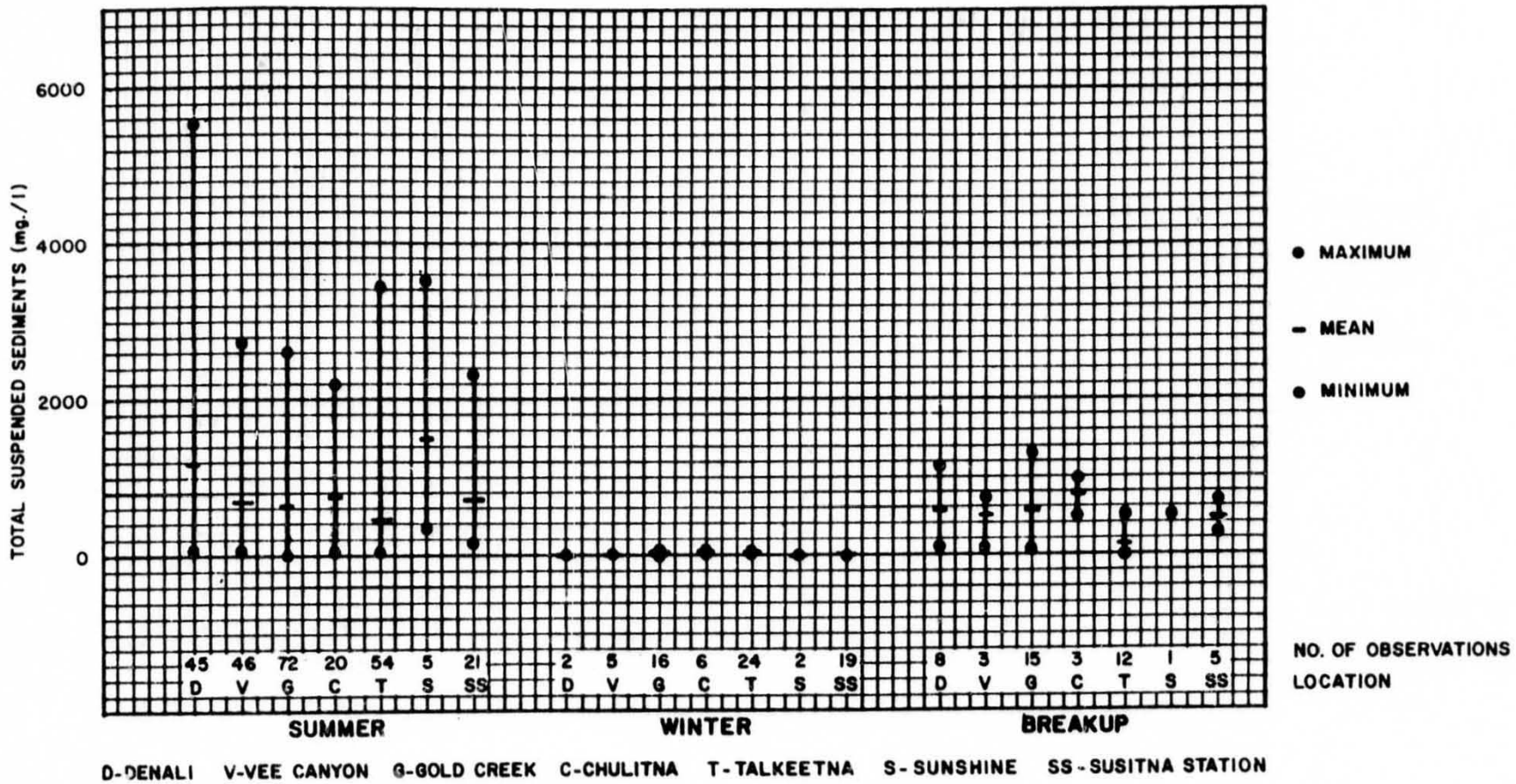
I. B. ESTABLISHED TO PROTECT SENSITIVE IMPORTANT FISH SPECIES, AND FOR THE SUCCESSFUL MIGRATION, SPAWNING, EGG-INCUBATION, FRY-REARING, AND OTHER REPRODUCTIVE FUNCTIONS OF IMPORTANT SPECIES.

2. MAXIMUM VALUES OF 12°C AT DENALI ON JUNE 4 AND 5, 1980; 15.0 °C AT GOLD CREEK ON JULY 3 AND 4, 1979; AND 16.5 °C AT SUSITNA STATION ON JULY 9, 1976 HAVE BEEN RECORDED BY USGS CONTINUOUS RECORDING EQUIPMENT, HOWEVER THESE WERE NOT INCLUDED IN THE ABOVE COMPILATION. ONLY DISCRETE OBSERVATIONS WERE UTILIZED SINCE CONTINUOUS RECORDERS ARE NOT PRESENT AT EACH STATION THROUGHOUT THE BASIN.

# DATA SUMMARY - TEMPERATURE

SOURCE : USGS

FIGURE E.2.71




NOTE:

1. A. CRITERION: NO MEASURABLE INCREASE ABOVE NATURAL CONDITIONS (ADEC 1979).

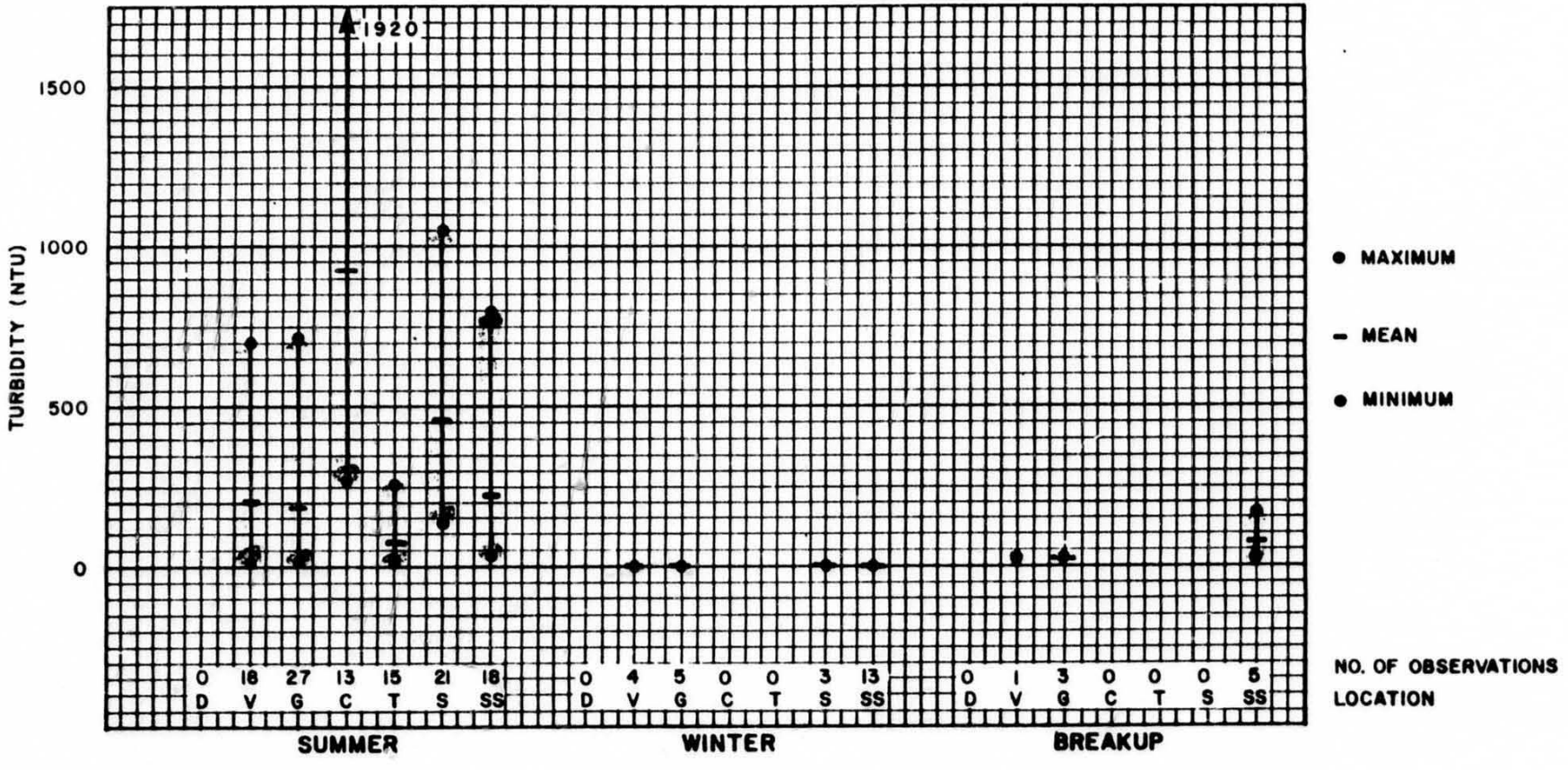
1. B ESTABLISHED TO PREVENT DELETERIOUS EFFECTS ON AQUATIC ANIMAL AND PLANT LIFE, THEIR REPRODUCTION AND HABITAT.

2. AT GOLD CREEK, 2 WINTER OBSERVATIONS WERE LESS THAN THE DETECTION LIMIT OF 1.0 mg./l.

## DATA SUMMARY-TOTAL SUSPENDED SEDIMENTS

SOURCE: USGS AND R&M

FIGURE E.2.78




NOTES:

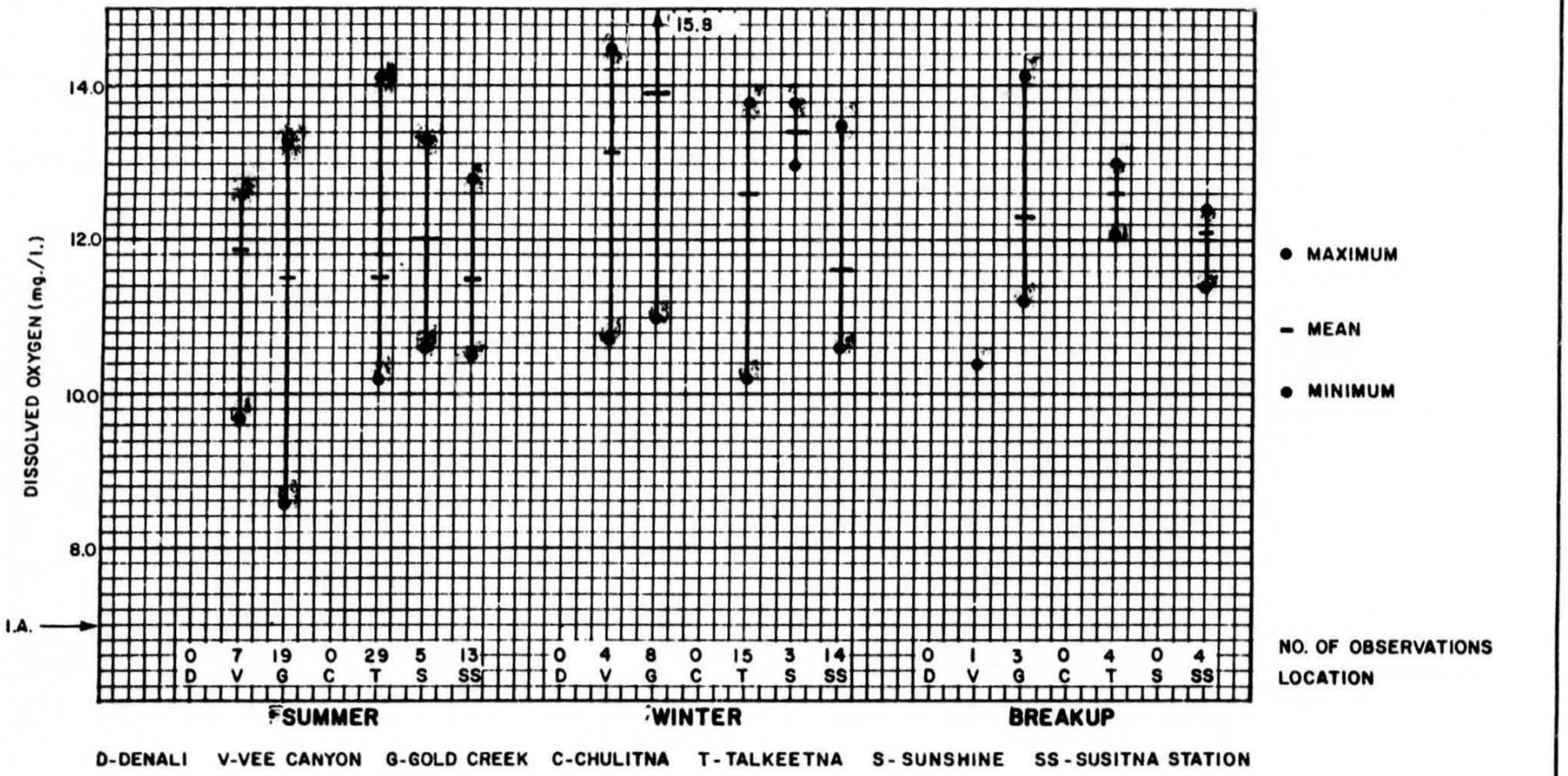
I.A. CRITERION SHALL NOT EXCEED 25 NTU ABOVE NATURAL CONDITIONS (ADEC 1979).

I.B. ESTABLISHED TO PREVENT THE REDUCTION OF THE COMPENSATION POINT FOR PHOTOSYNTHETIC ACTIVITY, WHICH MAY HAVE ADVERSE EFFECTS ON AQUATIC LIFE.

## DATA SUMMARY - TURBIDITY

SOURCE: USGS AND R&M

FIGURE E.2.81



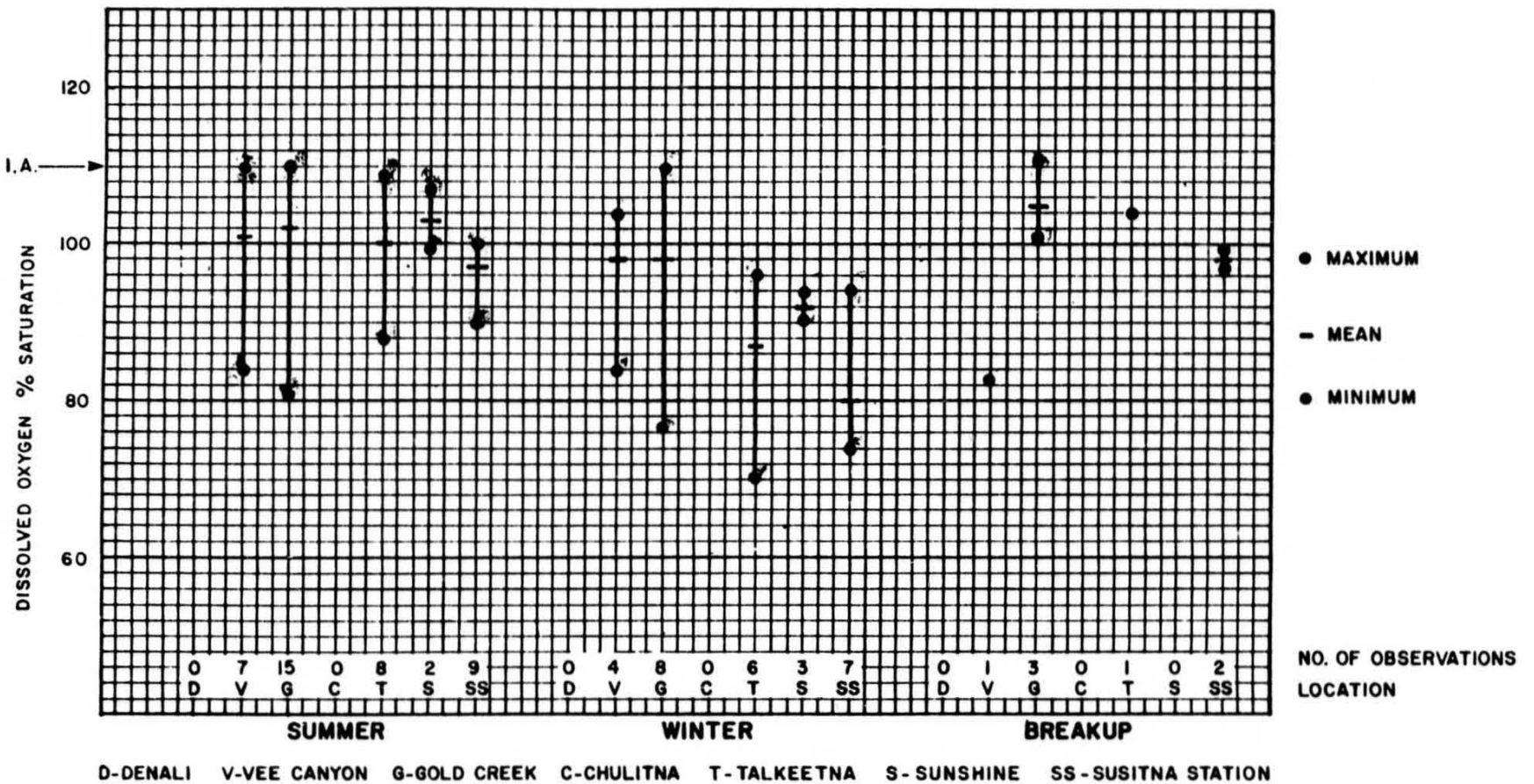

NOTES:

1. A. CRITERIA: GREATER THAN 7mg./l. BUT IN NO CASE SHALL DISSOLVED OXYGEN EXCEED 17 mg./l. (ADEC 1979).
1. B. ESTABLISHED FOR THE PROTECTION OF ANADROMOUS AND RESIDENT FISH.

## DATA SUMMARY- DISSOLVED OXYGEN

SOURCE: USGS AND R & M

FIGURE E.2.83



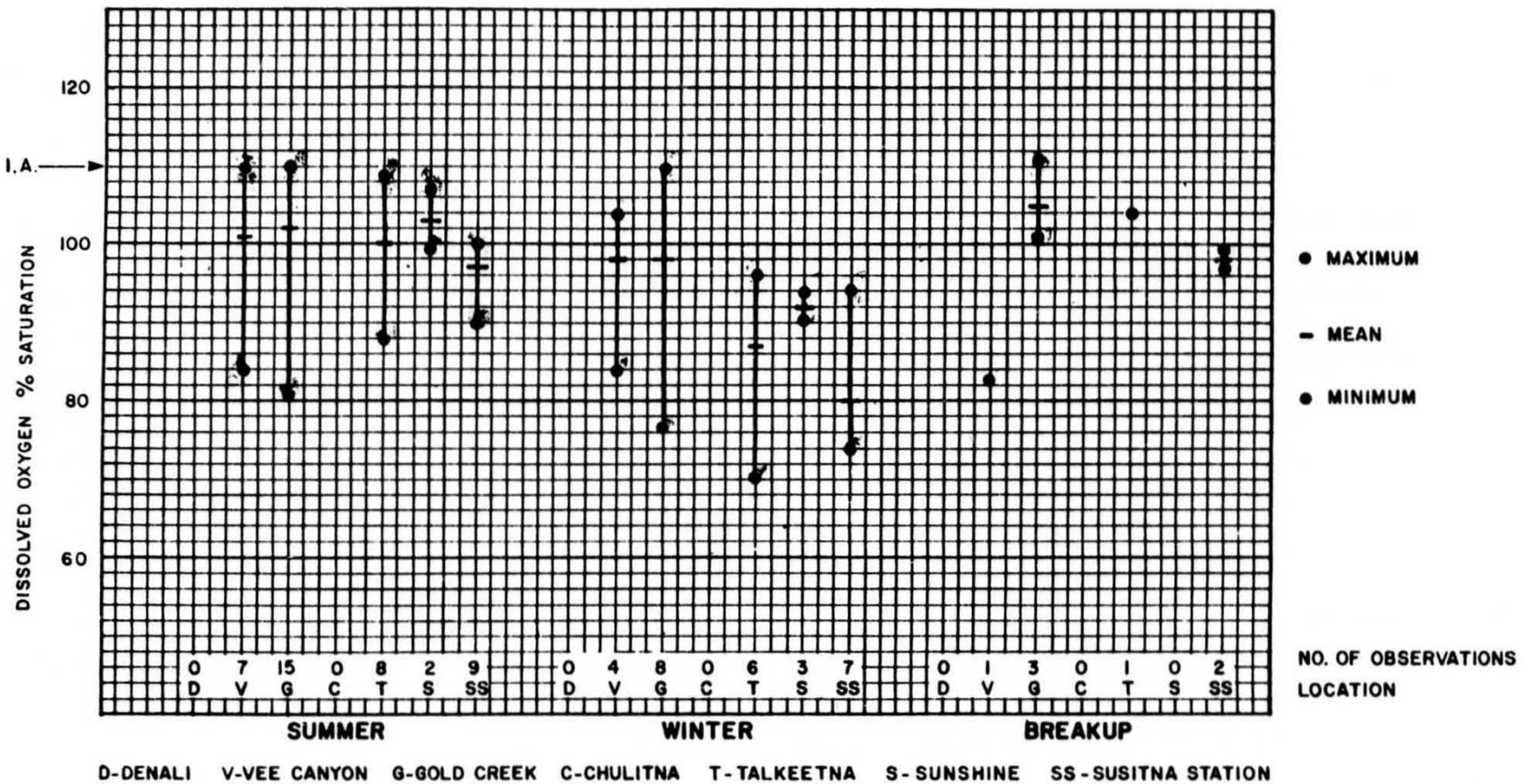

NOTES:

1. A. CRITERION: THE CONCENTRATION OF TOTAL DISSOLVED GAS SHALL NOT EXCEED 110 % SATURATION AT ANY POINT. (ADEC, 1979).
1. B. ESTABLISHED FOR THE PROTECTION OF ANADROMOUS AND RESIDENT FISH.

## DATA SUMMARY – DISSOLVED OXYGEN % SATURATION

SOURCE: USGS AND R&M

FIGURE E.2.84



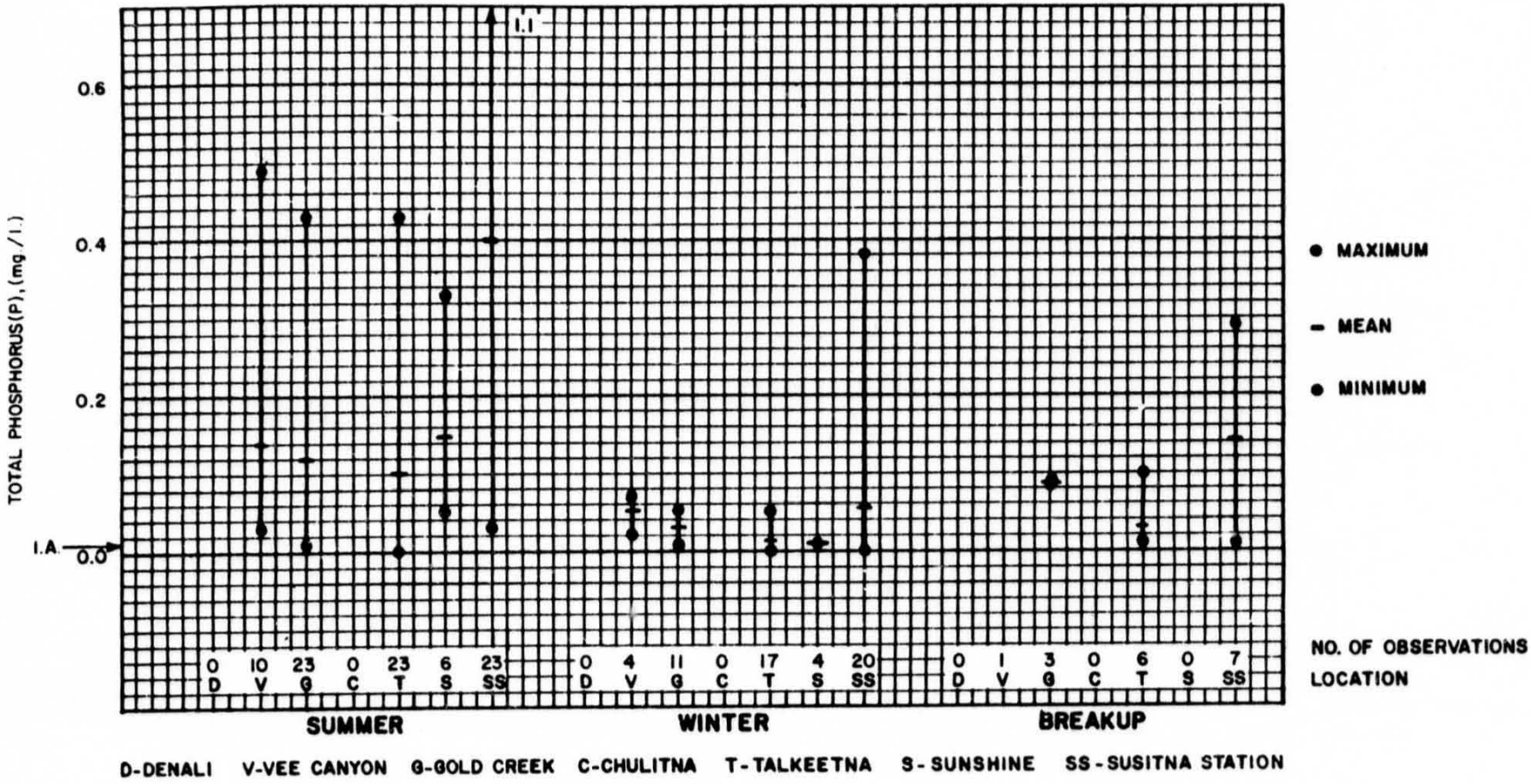

NOTES:

1. A. CRITERION: THE CONCENTRATION OF TOTAL DISSOLVED GAS SHALL NOT EXCEED 110 % SATURATION AT ANY POINT. (ADEC, 1979).
1. B. ESTABLISHED FOR THE PROTECTION OF ANADROMOUS AND RESIDENT FISH.

## DATA SUMMARY – DISSOLVED OXYGEN % SATURATION

SOURCE: USGS AND R&M

FIGURE E.2.84




NOTES:

[redacted]

1.B. ESTABLISHED TO PROTECT FRESHWATER AQUATIC ORGANISMS.

2. AT VEE CANYON, 4 SUMMER OBSERVATIONS, 2 WINTER OBSERVATIONS, AND THE 1 BREAKUP OBSERVATION WERE LESS THAN 0.05 mg./l.

3. AT GOLD CREEK, 6 SUMMER OBSERVATIONS, 3 WINTER OBSERVATIONS, AND 1 BREAKUP OBSERVATION WERE LESS THAN 0.05 mg./l.

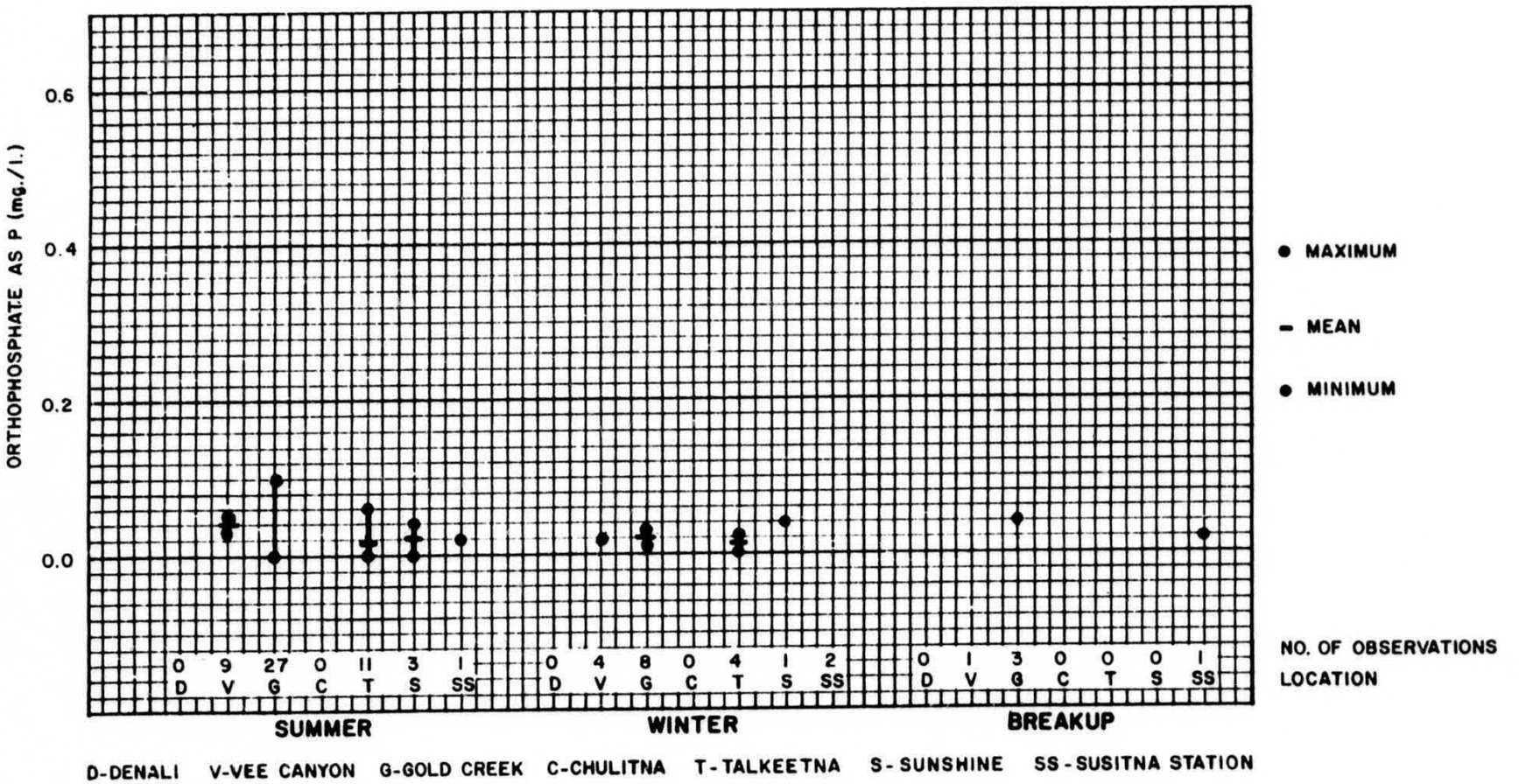
4. AT SUNSHINE, 2 WINTER OBSERVATIONS WERE LESS THAN 0.01 mg./l.

5. AT SUSITNA STATION, 2 WINTER OBSERVATIONS WERE LESS THAN 0.01 mg./l.

## DATA SUMMARY - TOTAL PHOSPHORUS

SOURCE USGS AND R & M

FIGURE E.2.86



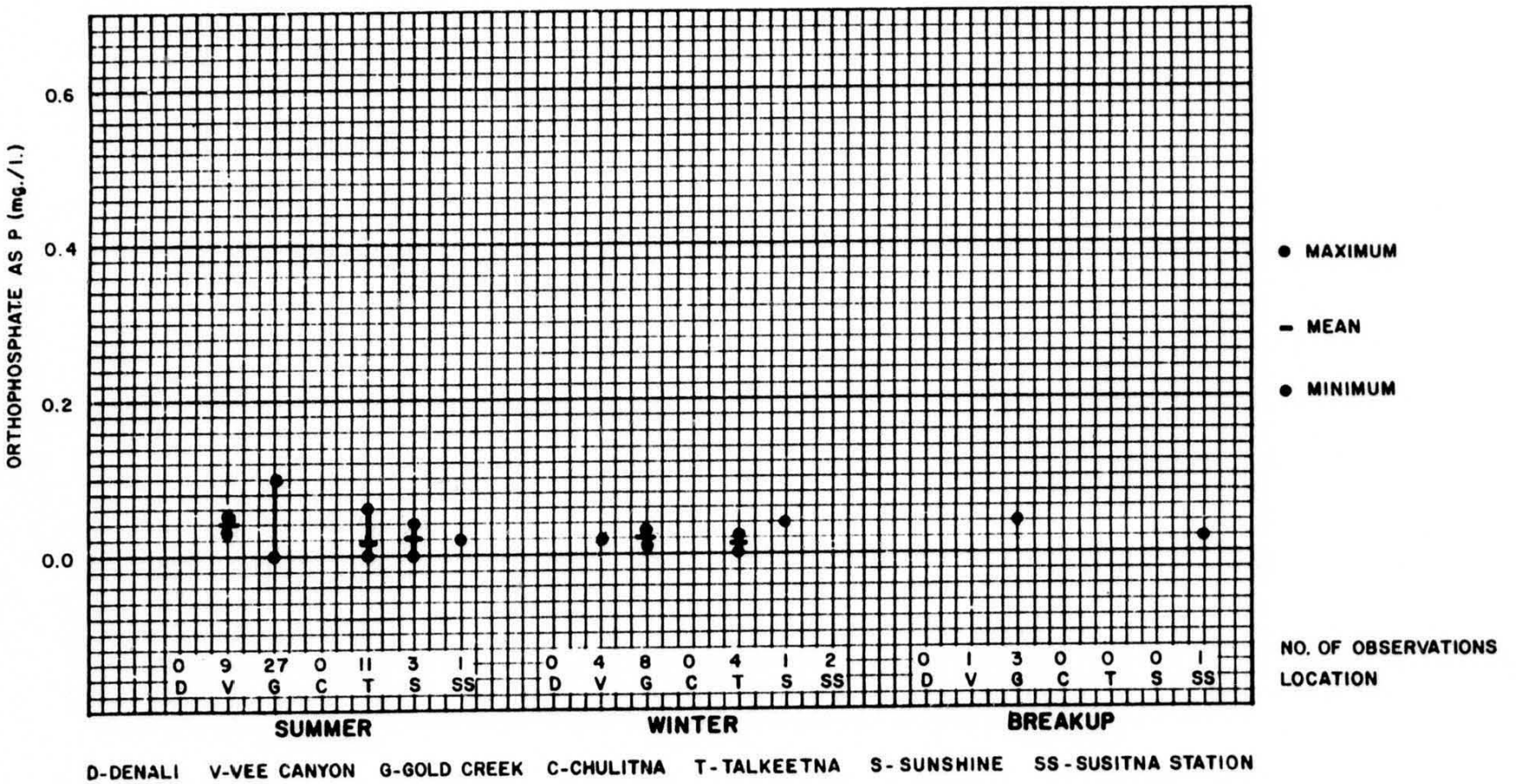

NOTES:

1. NO CRITERION ESTABLISHED.
2. AT VEE CANYON, 7 SUMMER OBSERVATIONS WERE LESS THAN 0.05 mg./l. 2 WINTER OBSERVATIONS AND THE 1 BREAKUP OBSERVATION WERE LESS THAN THE DETECTION LIMIT OF 0.01 mg./l.
3. AT GOLD CREEK, 13 SUMMER OBSERVATIONS WERE LESS THAN 0.02 mg./l. 2 WINTER OBSERVATIONS AND 2 BREAKUP OBSERVATIONS WERE LESS THAN THE DETECTION LIMIT OF 0.01 mg./l.
4. AT SUSITNA STATION, THE 2 WINTER OBSERVATIONS WERE LESS THAN 0.02 mg./l.

## DATA SUMMARY-ORTHOPHOSPHATE

SOURCE: USGS AND R&M.

FIGURE E.2.87



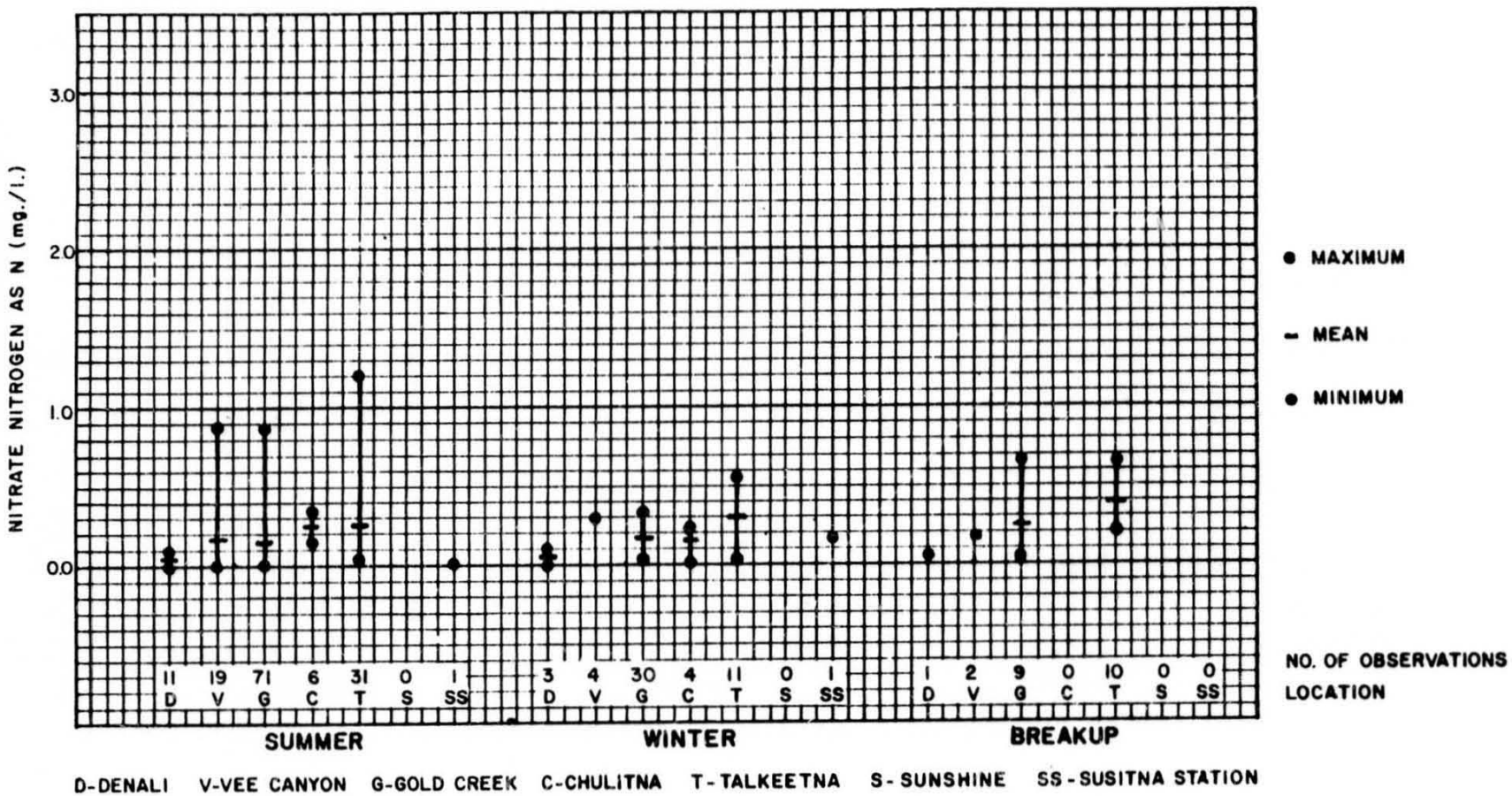

NOTES:

1. NO CRITERION ESTABLISHED.
2. AT VEE CANYON, 7 SUMMER OBSERVATIONS WERE LESS THAN 0.05 mg./l. 2 WINTER OBSERVATIONS AND THE 1 BREAKUP OBSERVATION WERE LESS THAN THE DETECTION LIMIT OF 0.01 mg./l.
3. AT GOLD CREEK, 13 SUMMER OBSERVATIONS WERE LESS THAN 0.02 mg./l. 2 WINTER OBSERVATIONS AND 2 BREAKUP OBSERVATIONS WERE LESS THAN THE DETECTION LIMIT OF 0.01 mg./l.
4. AT SUSITNA STATION, THE 2 WINTER OBSERVATIONS WERE LESS THAN 0.02 mg./l.

## DATA SUMMARY-ORTHOPHOSPHATE

SOURCE: USGS AND R&M.

FIGURE E.2.87




NOTES:

1.A. CRITERION: LESS THAN 10mg./l. (EPA 1976).

1.B. ESTABLISHED TO PROTECT WATER SUPPLIES.

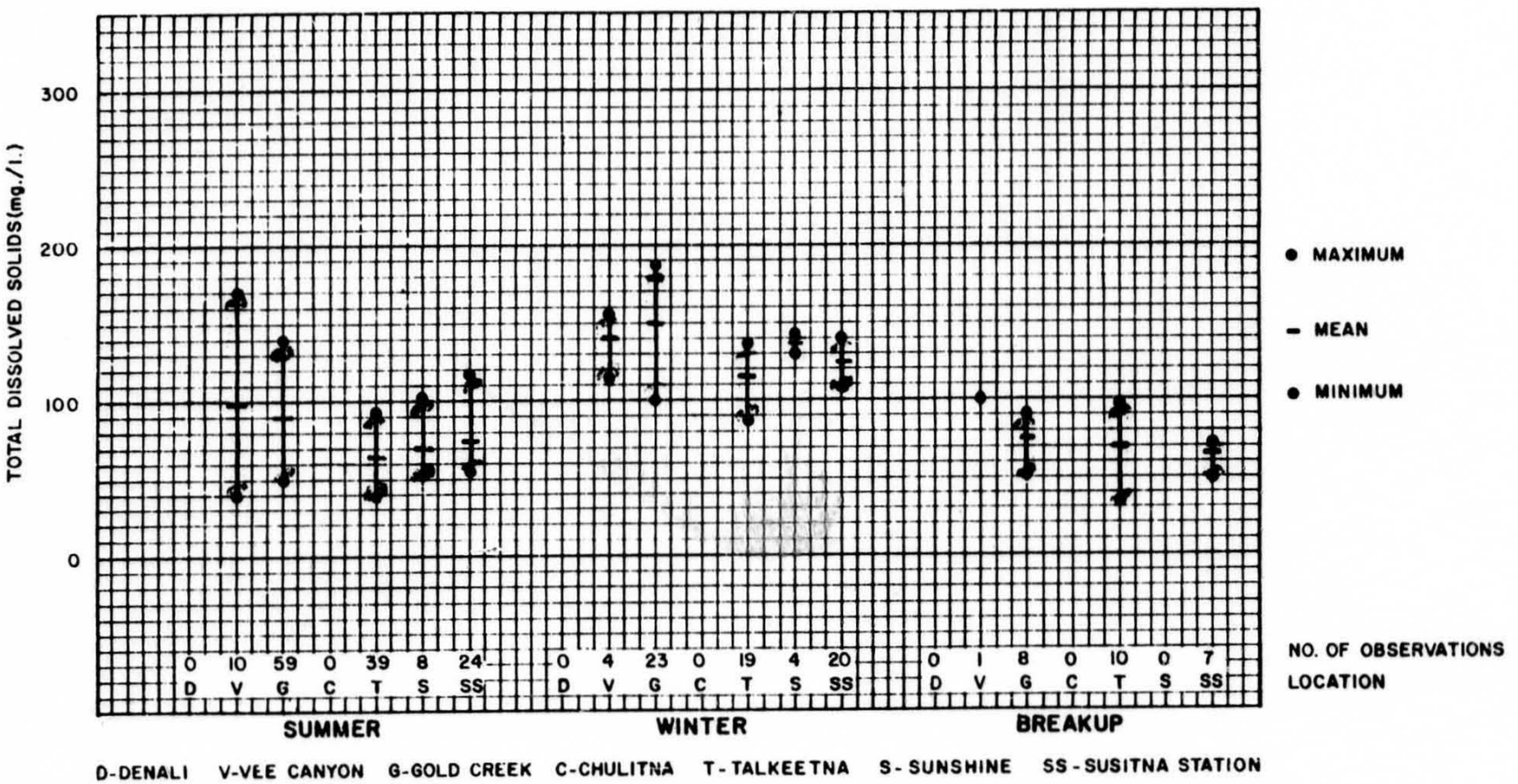
2. AT VEE CANYON, 5 SUMMER OBSERVATIONS, 3 WINTER OBSERVATIONS, AND 1 BREAKUP OBSERVATION WERE LESS THAN THE DETECTION LIMIT OF 0.10 mg./l.

3. AT GOLD CREEK, 6 SUMMER OBSERVATIONS, 2 WINTER OBSERVATIONS AND 2 BREAKUP OBSERVATIONS WERE LESS THAN THE DETECTION LIMIT OF 0.10 mg./l.

## DATA SUMMARY - NITRATE NITROGEN

SOURCE: USGS AND R&M

FIGURE E.2.88




NOTES:

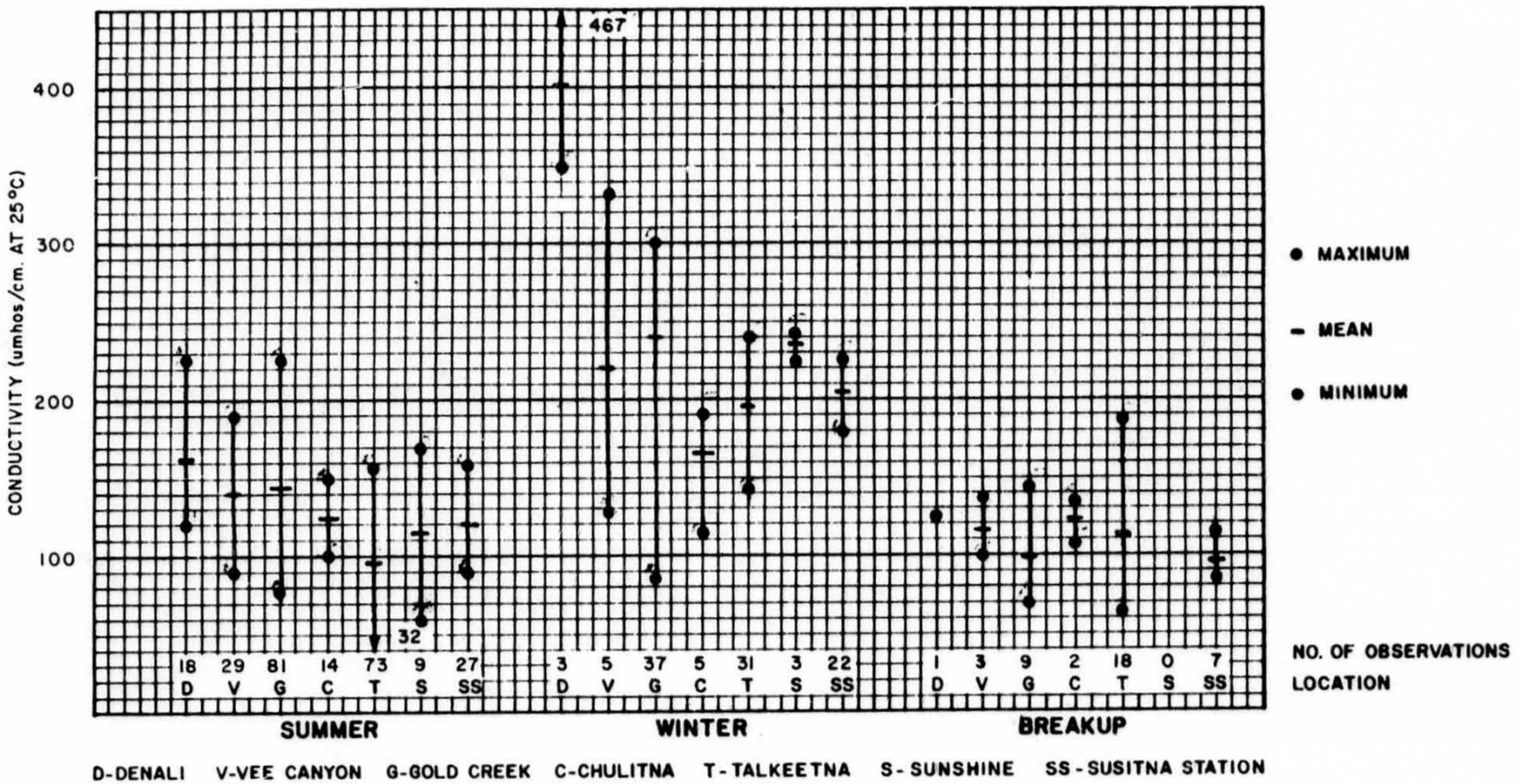
1.A. CRITERION: 1,500 mg./l. (ADEC 1979).

1.B. ESTABLISHED TO PROTECT NATURAL CONDITIONS OF FRESHWATER ECOSYSTEMS (500 mg./l. IS THE CRITERION FOR WATER SUPPLIES).

## DATA SUMMARY – TOTAL DISSOLVED SOLIDS

SOURCE: USGS AND R&M

FIGURE E.2.89



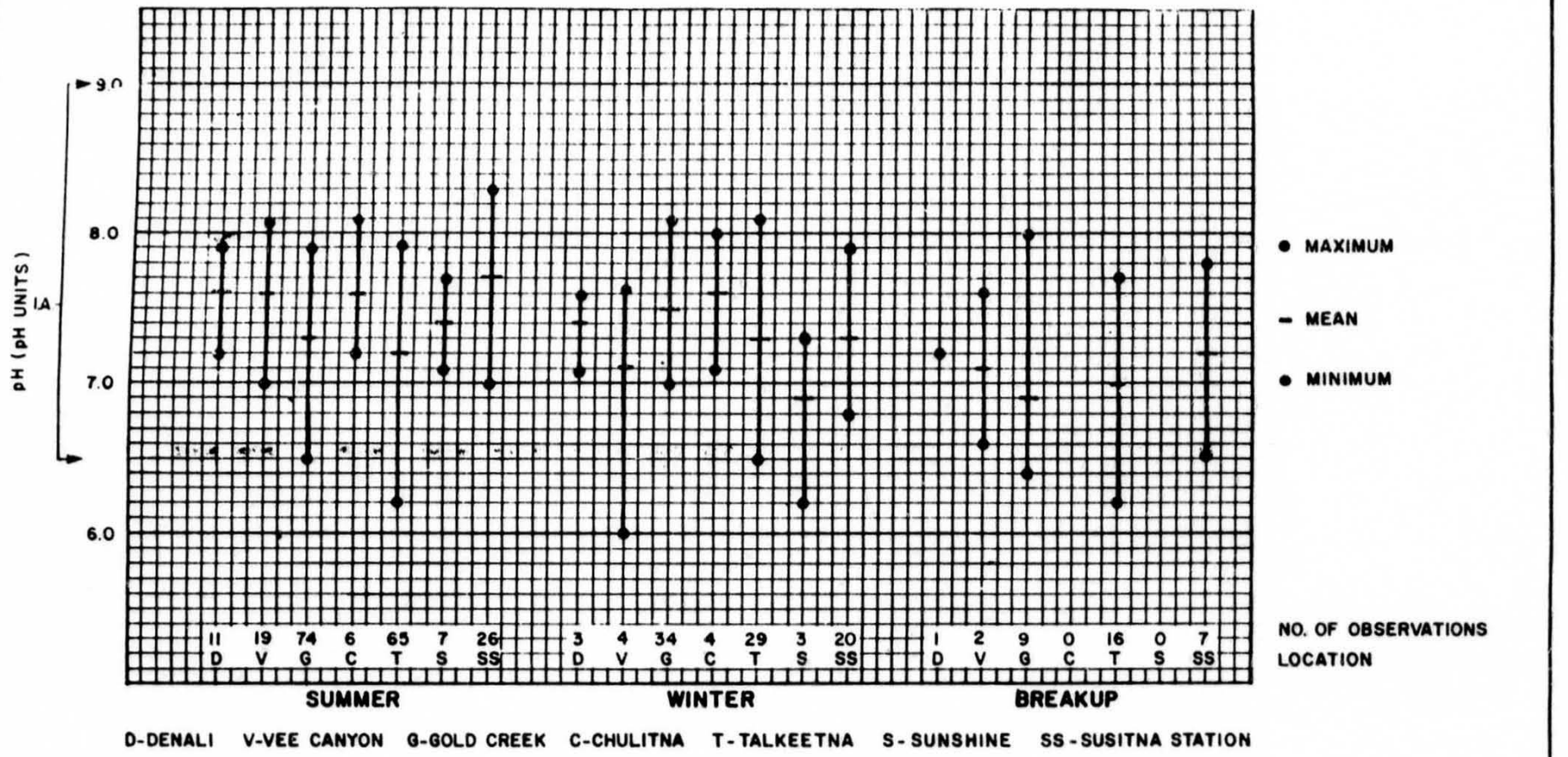

NOTES:

1. NO CRITERION ESTABLISHED.

## DATA SUMMARY - CONDUCTIVITY

SOURCE: USGS AND R&M

FIGURE E.2.90



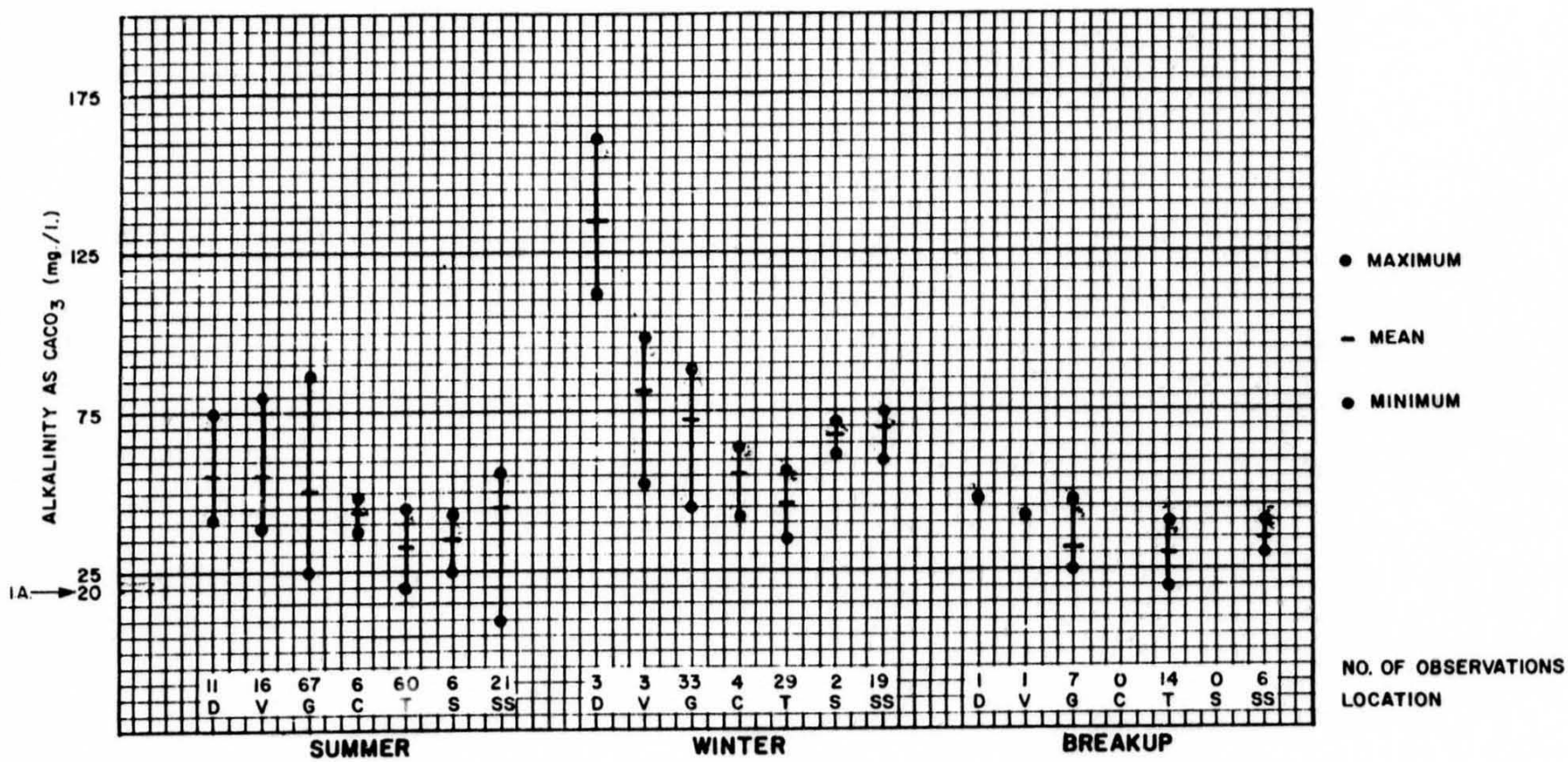

NOTES:

1. A. CRITERIA: NOT LESS THAN 6.5 OR GREATER THAN 9.0 pH UNITS. SHALL NOT VARY MORE THAN 0.5 pH UNITS FROM NATURAL CONDITION (ADEC 1979).
1. B. ESTABLISHED TO PROTECT FRESHWATER AQUATIC ORGANISMS.

## DATA SUMMARY- pH

SOURCE: USGS AND R&M

FIGURE E.2.98




NOTES:

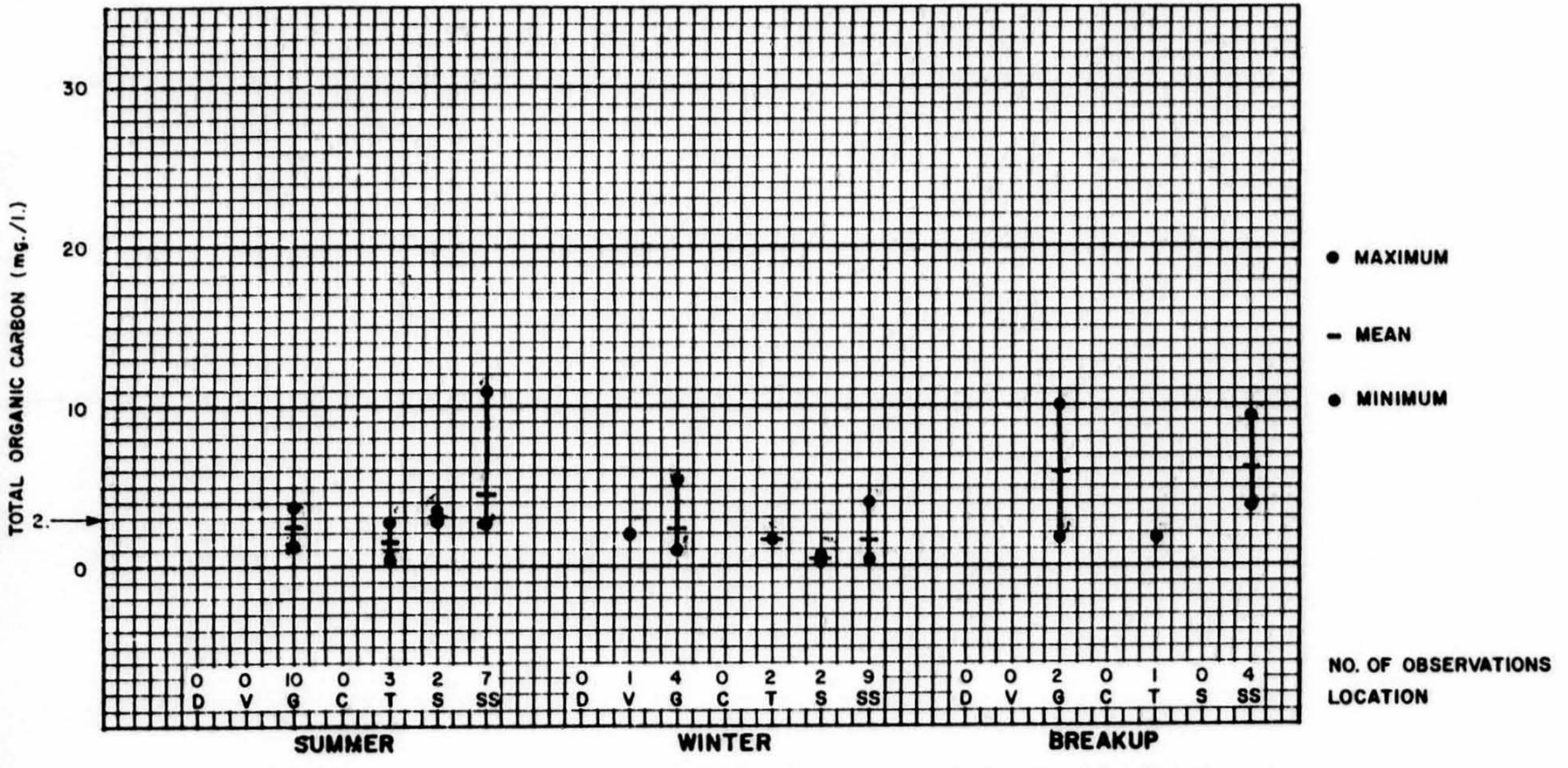
1. A. CRITERION: 20 mg./l. OR MORE EXCEPT WHERE NATURAL CONDITIONS ARE LESS (EPA 1976).

1. B. ESTABLISHED TO PROTECT FRESHWATER AQUATIC ORGANISMS.

## DATA SUMMARY - ALKALINITY

SOURCE: USGS AND R&M

FIGURE E.2.99



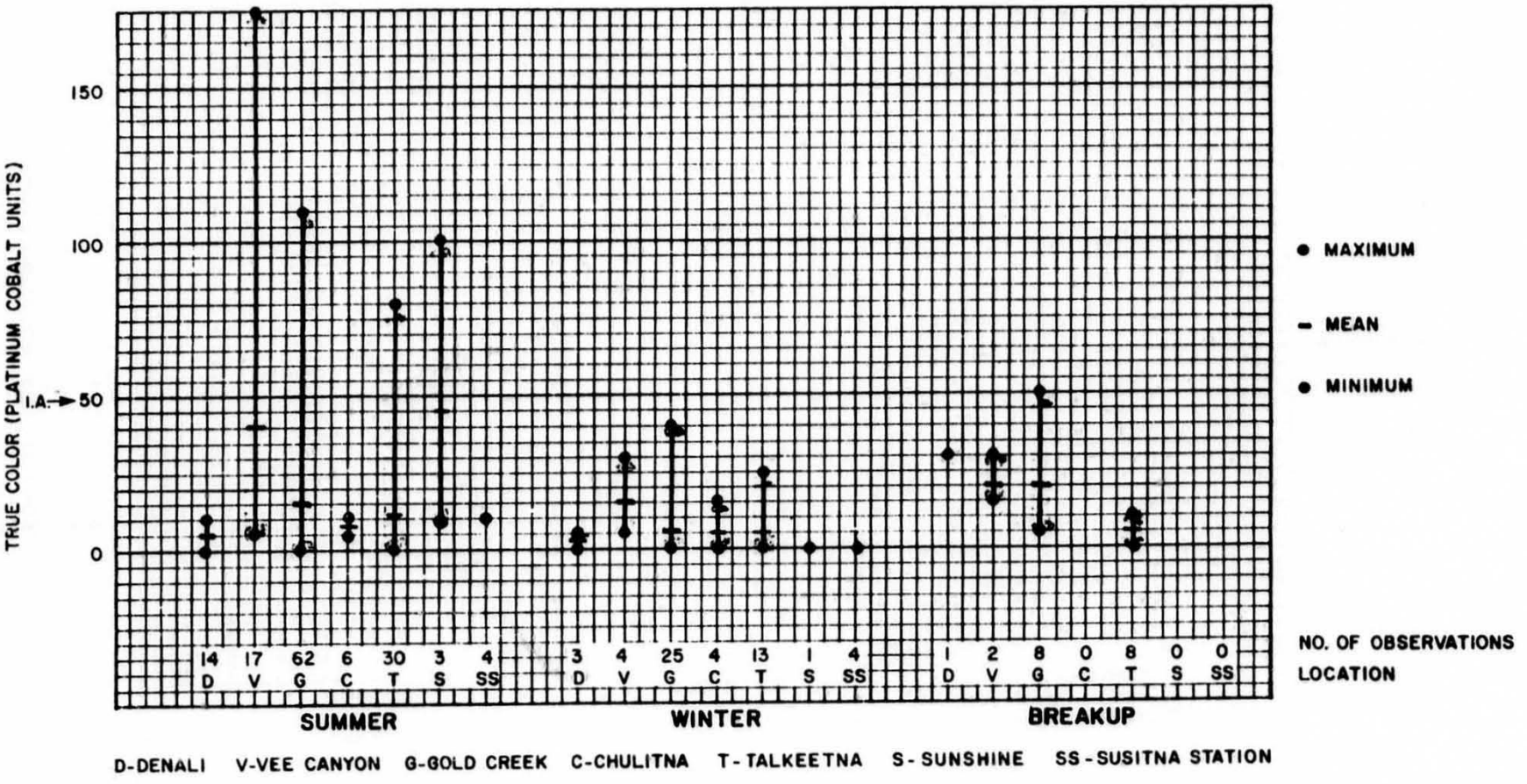

NOTES:

1. NO CRITERION ESTABLISHED.
2. WATERS CONTAINING LESS THAN 3.0 mg./l. HAVE BEEN OBSERVED TO BE RELATIVELY CLEAN (McNEELY et al. 1979).

## DATA SUMMARY- TOTAL ORGANIC CARBON

SOURCE: USGS AND R&M

FIGURE E.2.101




NOTES:

I.A. CRITERION: SHALL NOT EXCEED 50 UNITS (ADEC 1979).

I.B. ESTABLISHED TO PREVENT THE REDUCTION OF PHOTOSYNTHETIC ACTIVITY WHICH MAY HAVE DELETERIOUS EFFECTS ON AQUATIC LIFE.

2. AT DENALI, 1 SUMMER OBSERVATION WAS LESS THAN 5 UNITS. ONE SUMMER OBSERVATION WAS GREATER THAN 5 UNITS.

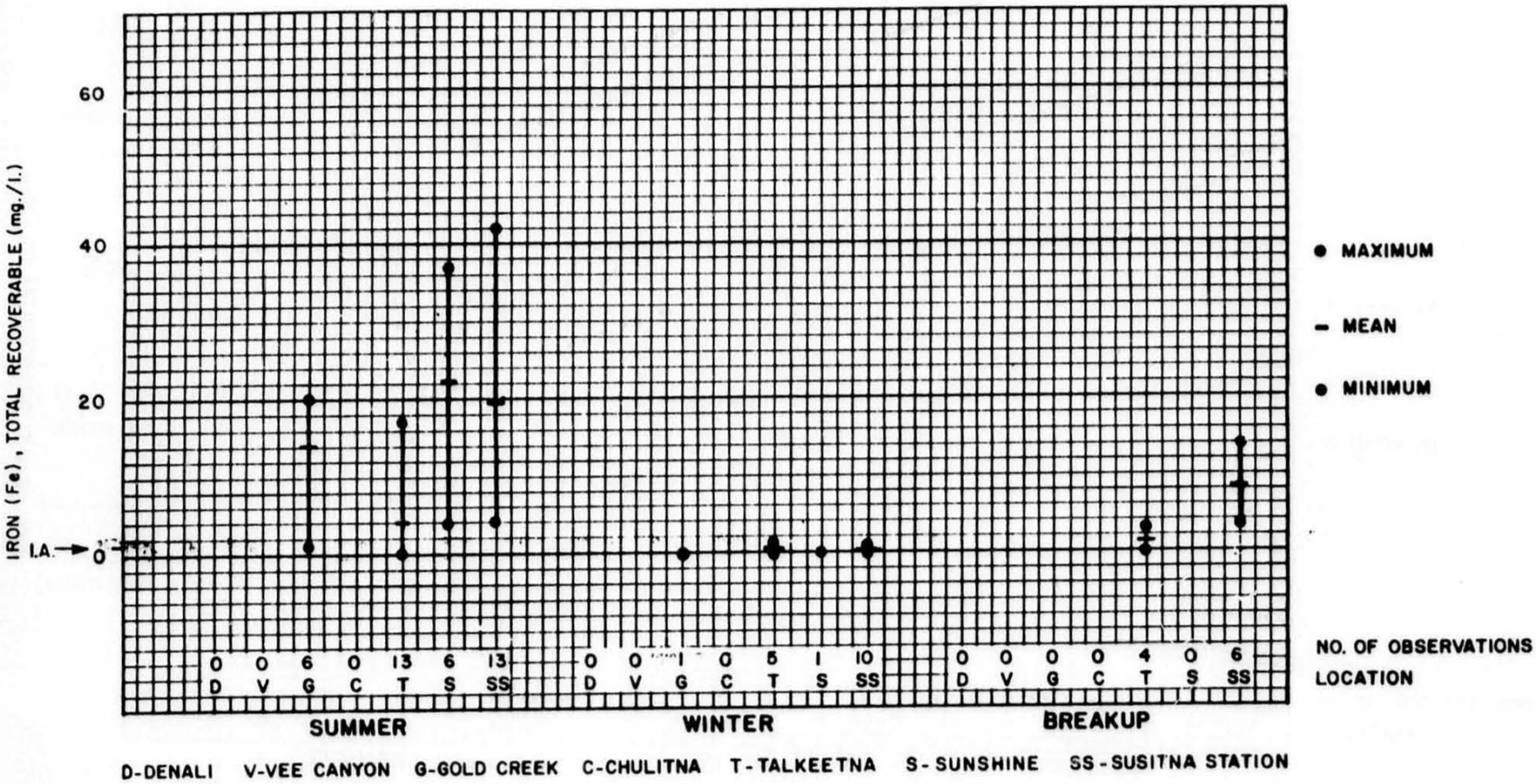
3. AT SUSITNA STATION, 2 SUMMER OBSERVATIONS AND 2 WINTER OBSERVATIONS WERE LESS THAN 5 UNITS.

4. AT TALKEETNA, 1 WINTER OBSERVATION WAS LESS THAN 5 UNITS.

# DATA SUMMARY - TRUE COLOR

SOURCE: USGS AND R&M

FIGURE E.2.103




NOTES:

I.A. CRITERION: LESS THAN 1.0 mg./l. (EPA 1976; SITTIG 1981).

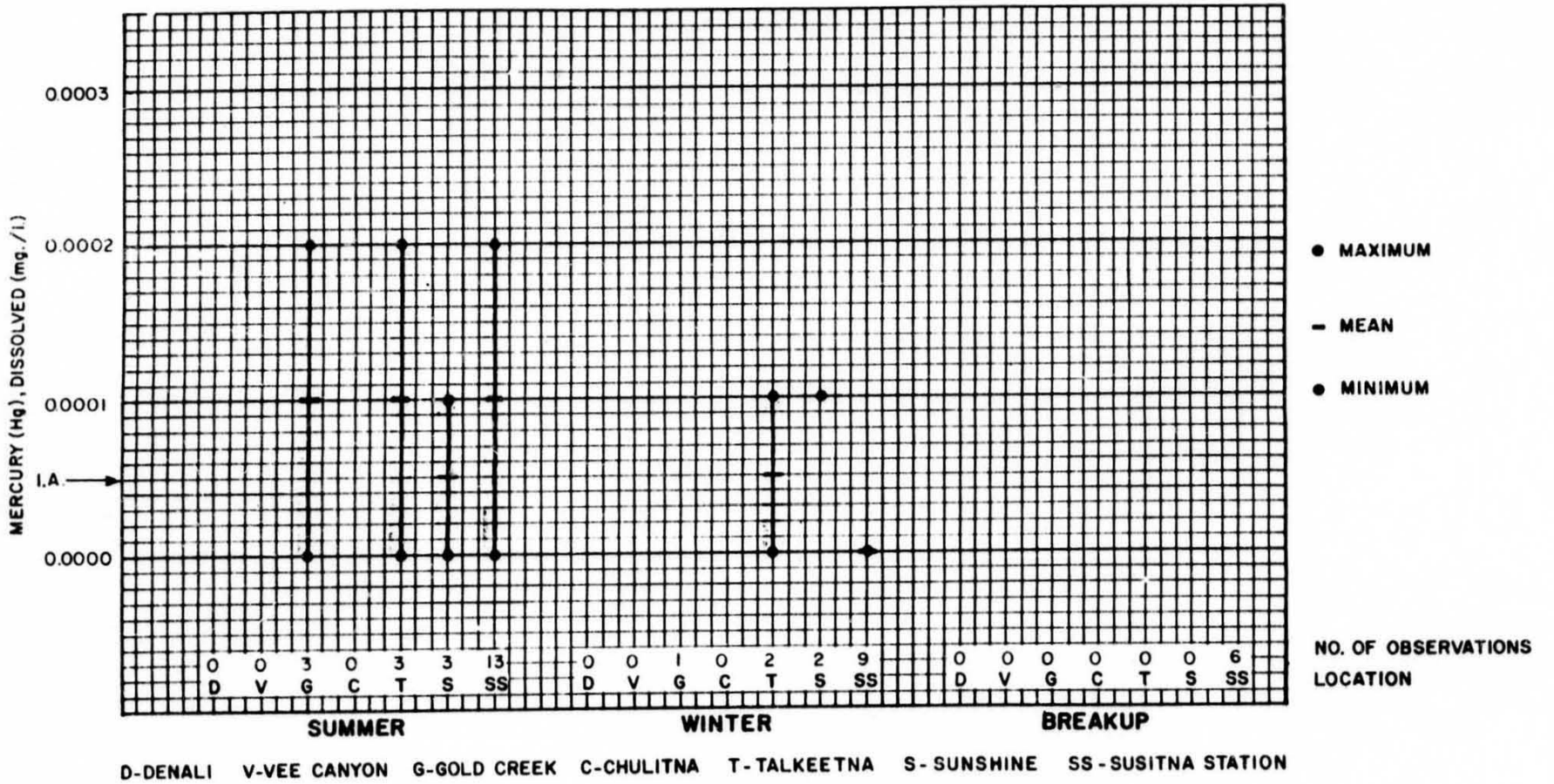
I.B. ESTABLISHED TO PROTECT FRESHWATER AQUATIC ORGANISMS.

2. (t) = TOTAL RECOVERABLE.

## DATA SUMMARY - IRON (t)

SOURCE: USGS

FIGURE E.2.III




NOTES:

I.A. CRITERION: LESS THAN 0.00005 mg./l. (EPA 1976).

I.B. ESTABLISHED TO PROTECT FRESHWATER AQUATIC ORGANISMS.

2. AT GOLD CREEK, 1 SUMMER OBSERVATION AND THE 1 WINTER OBSERVATION WERE LESS THAN 0.001 mg./l.

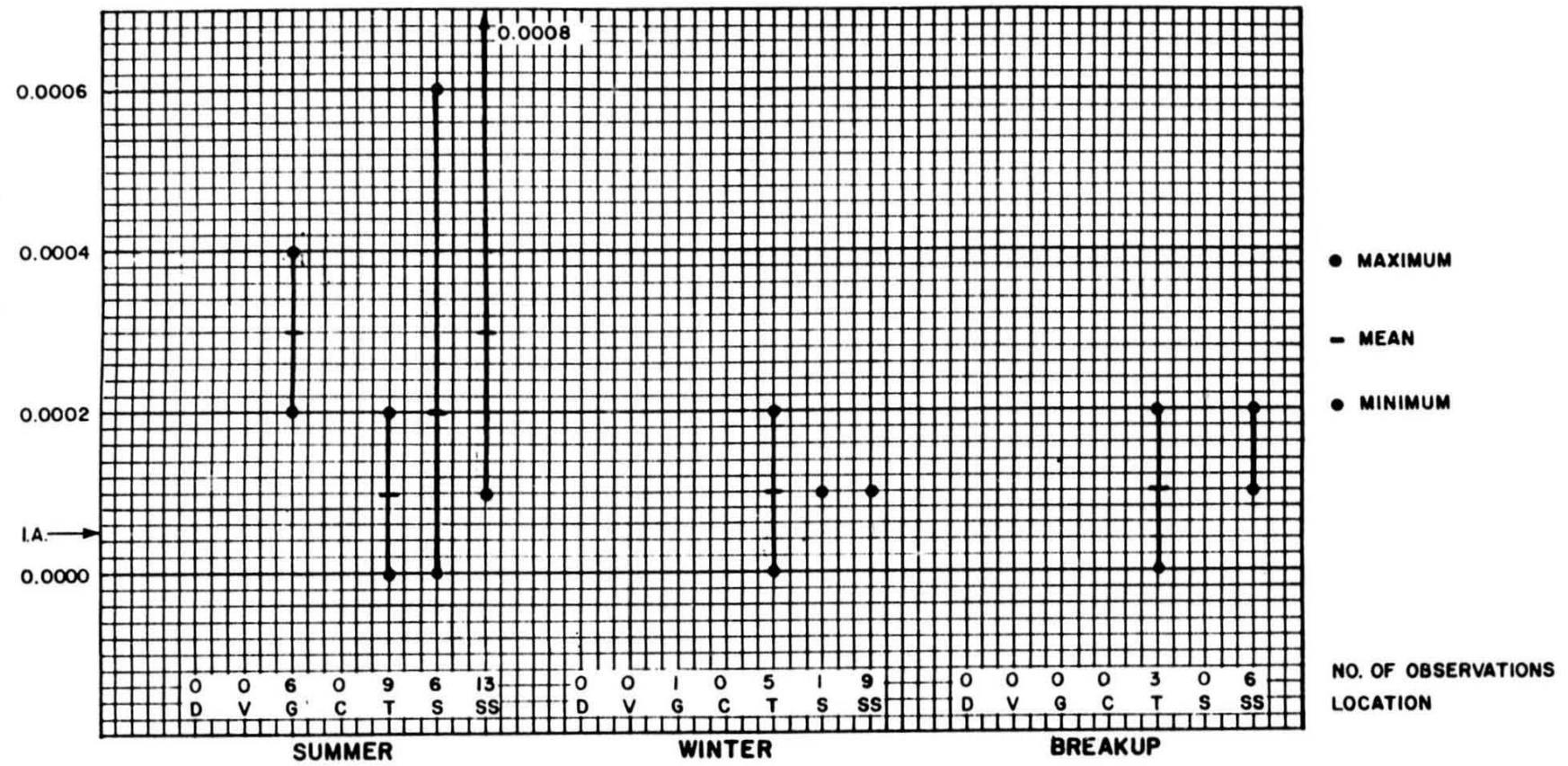
3. AT SUSITNA STATION, 8 SUMMER OBSERVATIONS, 7 WINTER OBSERVATIONS, AND THE 6 BREAKUP OBSERVATIONS WERE LESS THAN 0.0005 mg./l.

4. (d) = DISSOLVED

# DATA SUMMARY - MERCURY (d)

SOURCE: USGS

FIGURE E.2.115




D-DENALI V-VEE CANYON G-GOLD CREEK C-CHULITNA T-TALKEETNA S-SUNSHINE SS-SUSITNA STATION

NOTES:

I.A. CRITERION: LESS THAN 0.00005 mg./l. (EPA 1976).

I.B. ESTABLISHED TO PROTECT FRESHWATER AQUATIC ORGANISMS.

2. AT TALKEETNA, I SUMMER OBSERVATION WAS LESS THAN 0.0005 mg./l.

3. AT SUSITNA STATION, 7 SUMMER OBSERVATIONS, 7 WINTER OBSERVATIONS AND 4 BREAKUP OBSERVATIONS WERE LESS THAN 0.0005 mg./l.

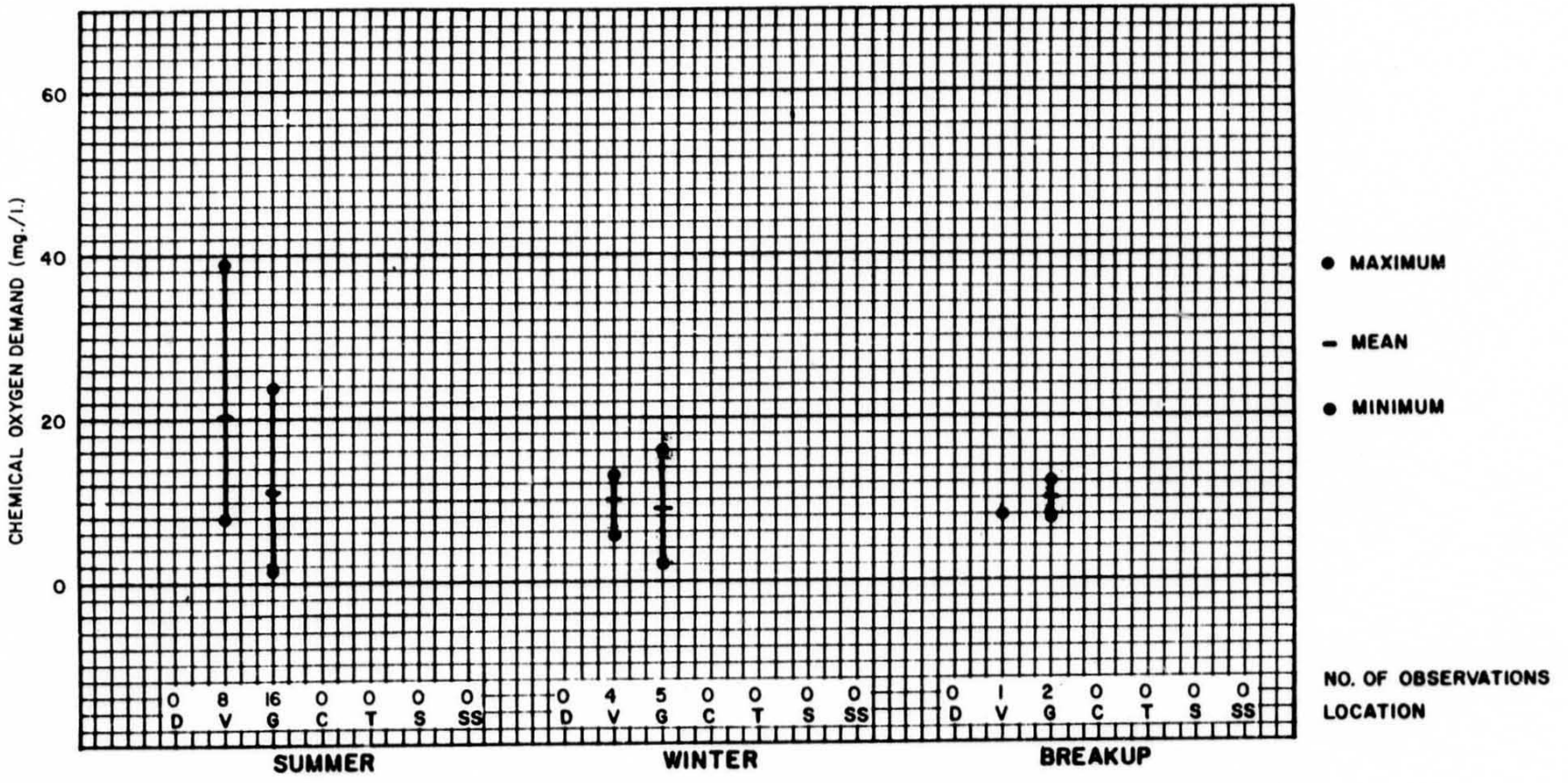
4. AT GOLD CREEK, THE I WINTER OBSERVATION WAS LESS THAN 0.0005 mg./l.

5. (t) = TOTAL RECOVERABLE.

# DATA SUMMARY - MERCURY (t)

SOURCE: USGS

FIGURE E.2.116



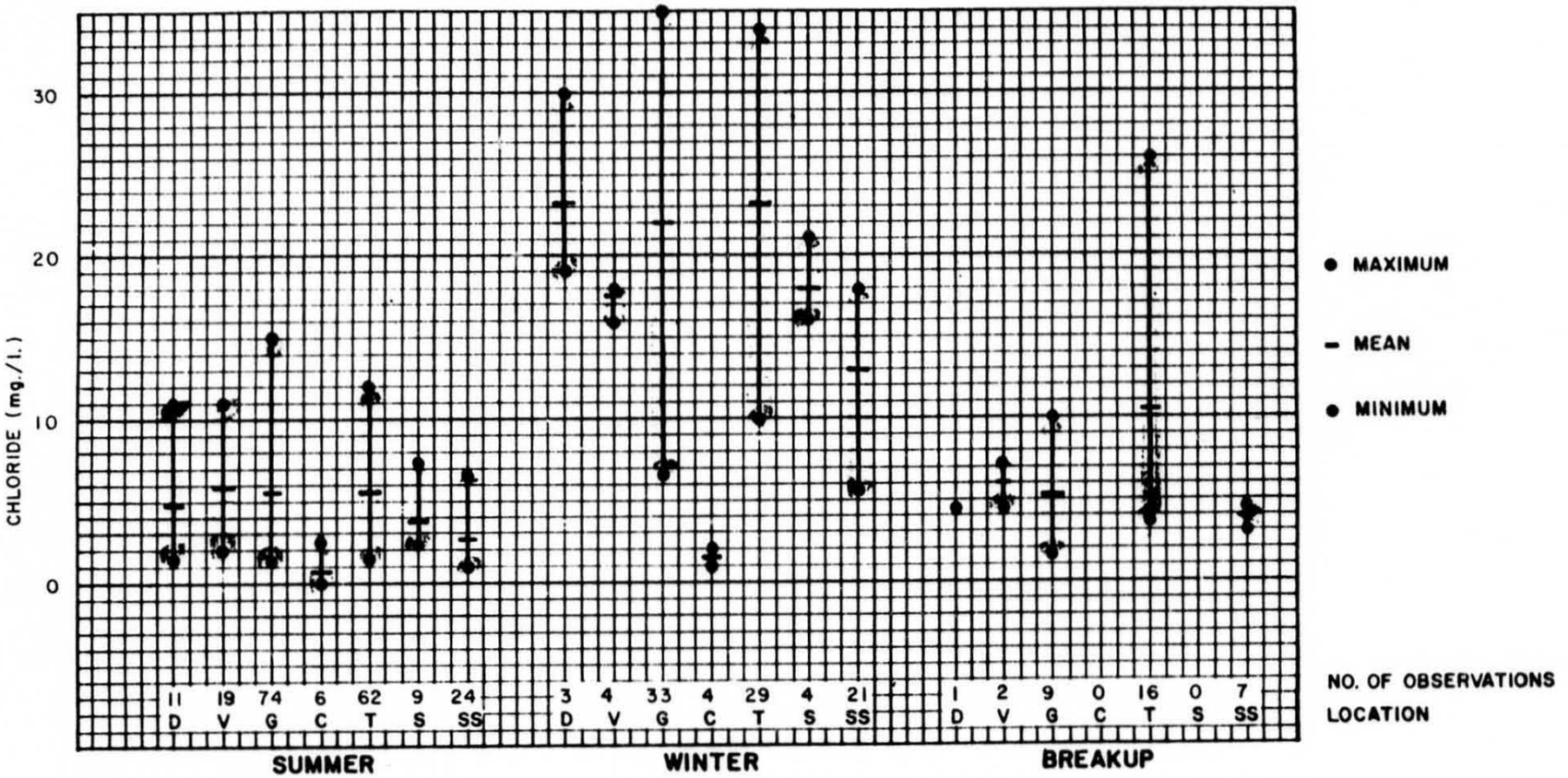

NOTES:

1. NO CRITERION ESTABLISHED.
2. AT GOLD CREEK, 2 SUMMER OBSERVATIONS WERE LESS THAN 1.0 mg./l.

## DATA SUMMARY - CHEMICAL OXYGEN DEMAND

SOURCE: R&M

FIGURE E.2.102




NOTES:

1. A. CRITERION: LESS THAN 200 mg/l (ADEC 1979).

1. B ESTABLISHED TO PROTECT WATER SUPPLIES.

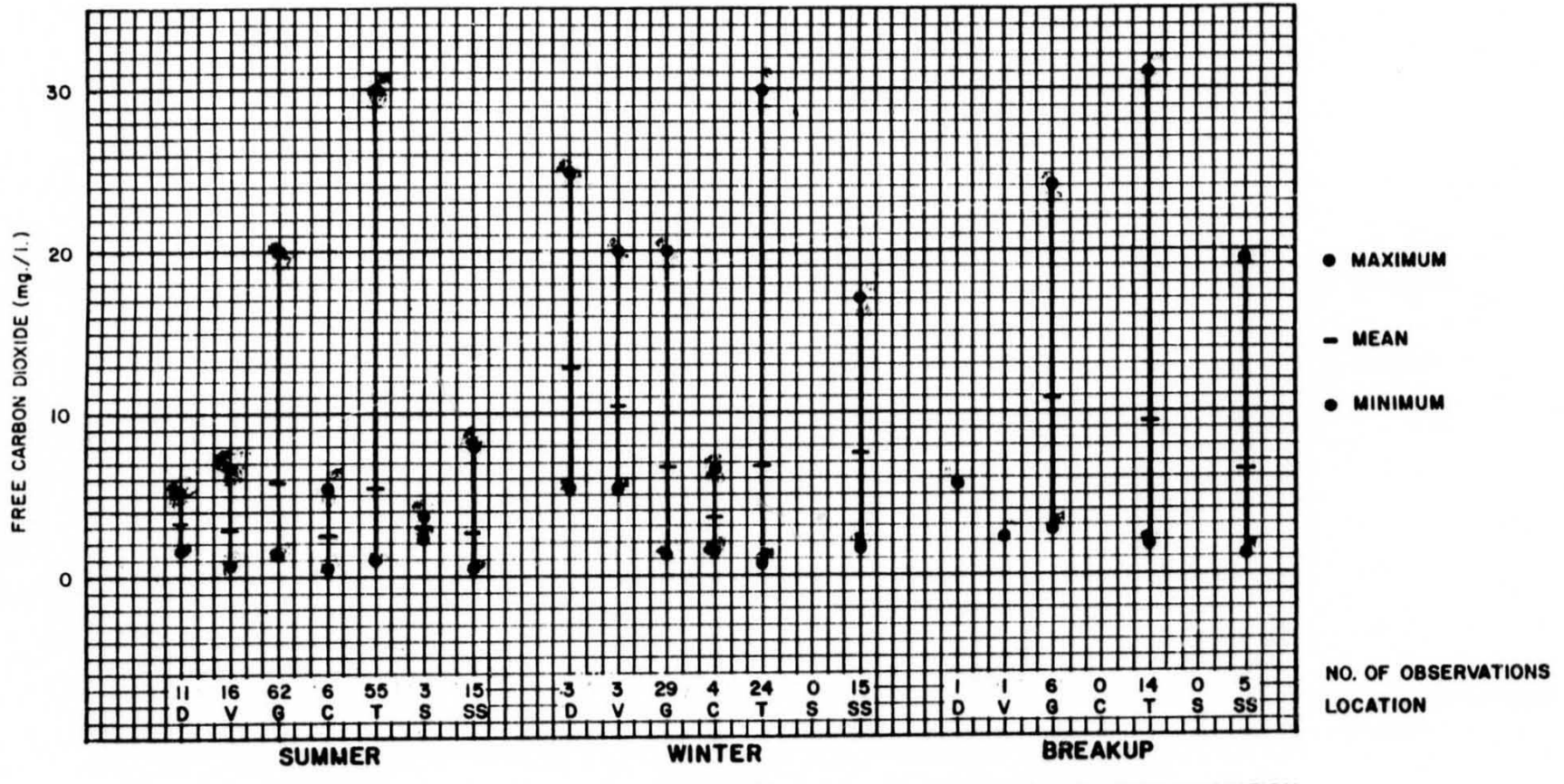
2 AT VEE CANYON, 3 SUMMER OBSERVATIONS WERE LESS THAN THE DETECTION LIMIT OF 10 mg/l

3 AT GOLD CREEK, 2 SUMMER OBSERVATIONS WERE LESS THAN THE DETECTION LIMIT OF 10 mg/l.

## DATA SUMMARY – CHLORIDE

SOURCE: USGS AND R&M

FIGURE E.2.92



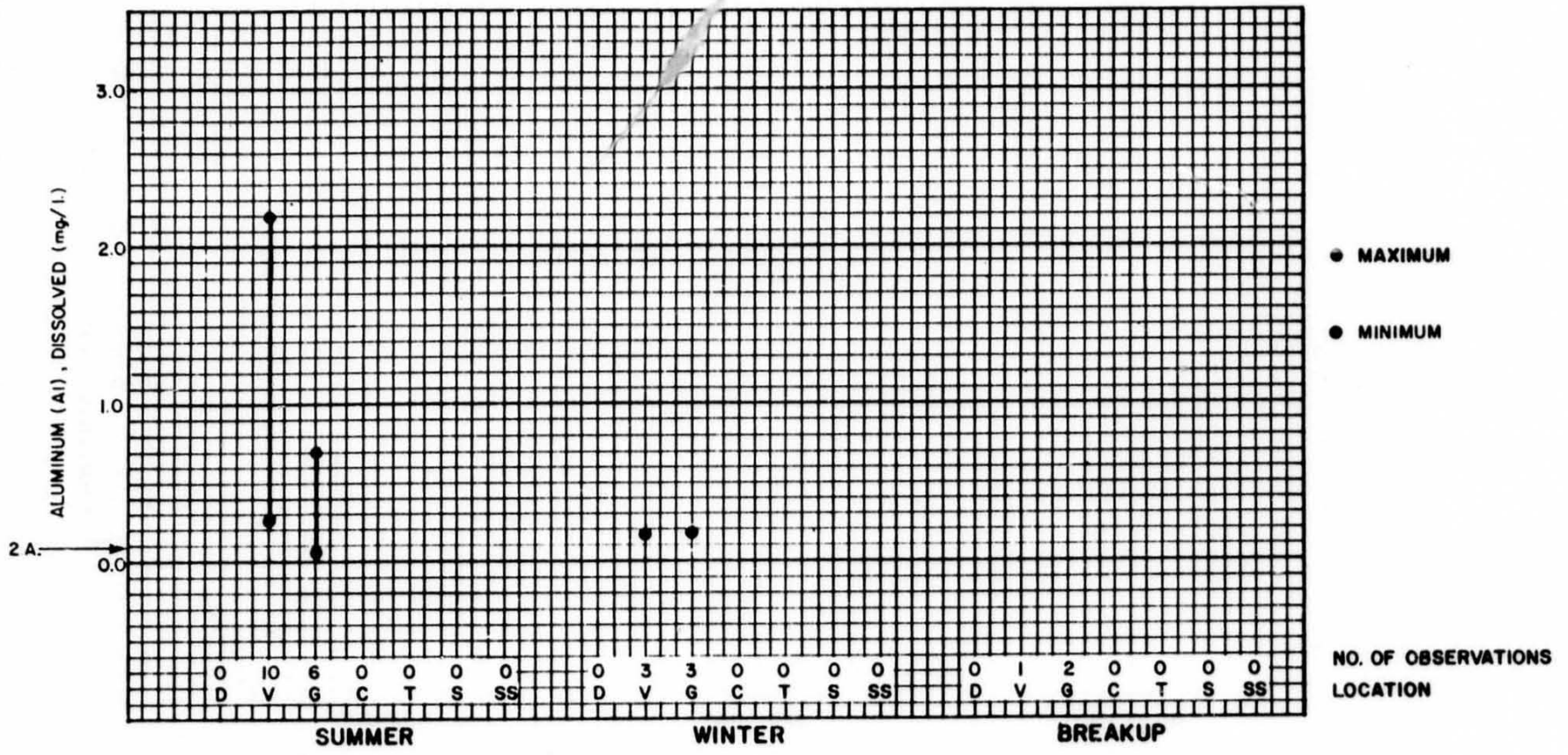

NOTE:

1. NO CRITERION ESTABLISHED.

## DATA SUMMARY - FREE CARBON DIOXIDE

SOURCE: USGS AND R&M

FIGURE E.2.100



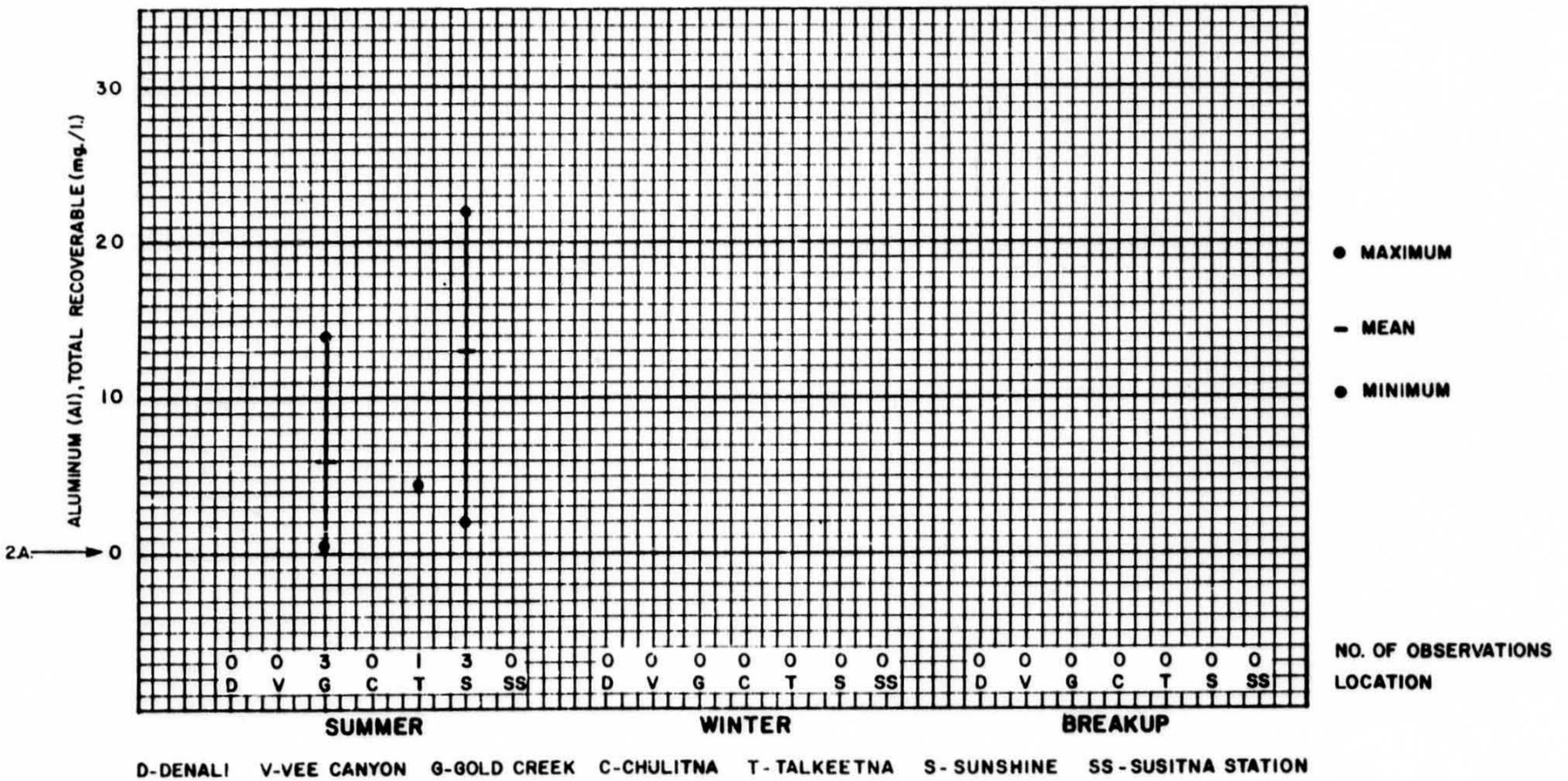

NOTES.

1. NO CRITERION ESTABLISHED.
2. A A LIMIT OF 0.073 mg/l HAS BEEN SUGGESTED BY EPA (SITTIG 1981).
2. B. THIS SUGGESTED LIMIT IS BASED ON THE EFFECTS OF ALUMINUM ON HUMAN HEALTH.
3. AT VEE CANYON, 7 SUMMER OBSERVATIONS WERE LESS THAN 0.10 mg/l TWO WINTER OBSERVATIONS AND THE ONE SUMMER OBSERVATION WERE LESS THAN THE DETECTION LIMIT OF 0.05 mg/l.
4. AT GOLD CREEK, 4 SUMMER OBSERVATIONS, 2 WINTER OBSERVATIONS AND THE 2 BREAKUP OBSERVATIONS WERE LESS THAN THE DETECTION LIMIT OF 0.05 mg/l.
5. (d) = DISSOLVED.

SOURCE · R&M

## DATA SUMMARY - ALUMINUM (d)

FIGURE E.2.104



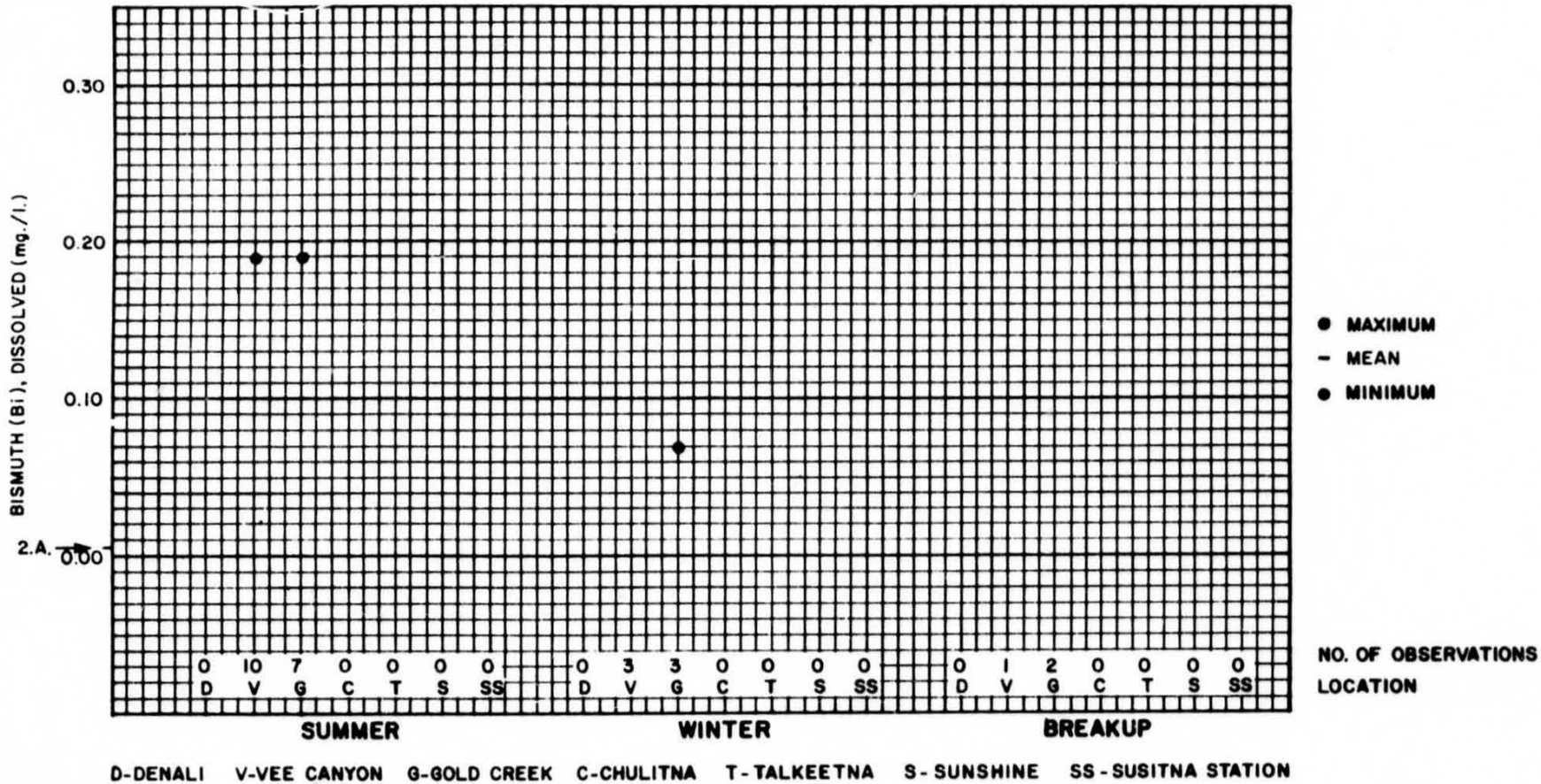

NOTES:

1. NO CRITERION ESTABLISHED.
2. A. A LIMIT OF 0.073 mg./l. HAS BEEN SUGGESTED BY EPA (SITTIG 1981).
   B. THIS SUGGESTED LIMIT IS BASED ON THE EFFECTS OF ALUMINUM ON HUMAN HEALTH.
3. (t) = TOTAL RECOVERABLE.

## DATA SUMMARY - ALUMINUM (t)

SOURCE: USGS

FIGURE E.2.105



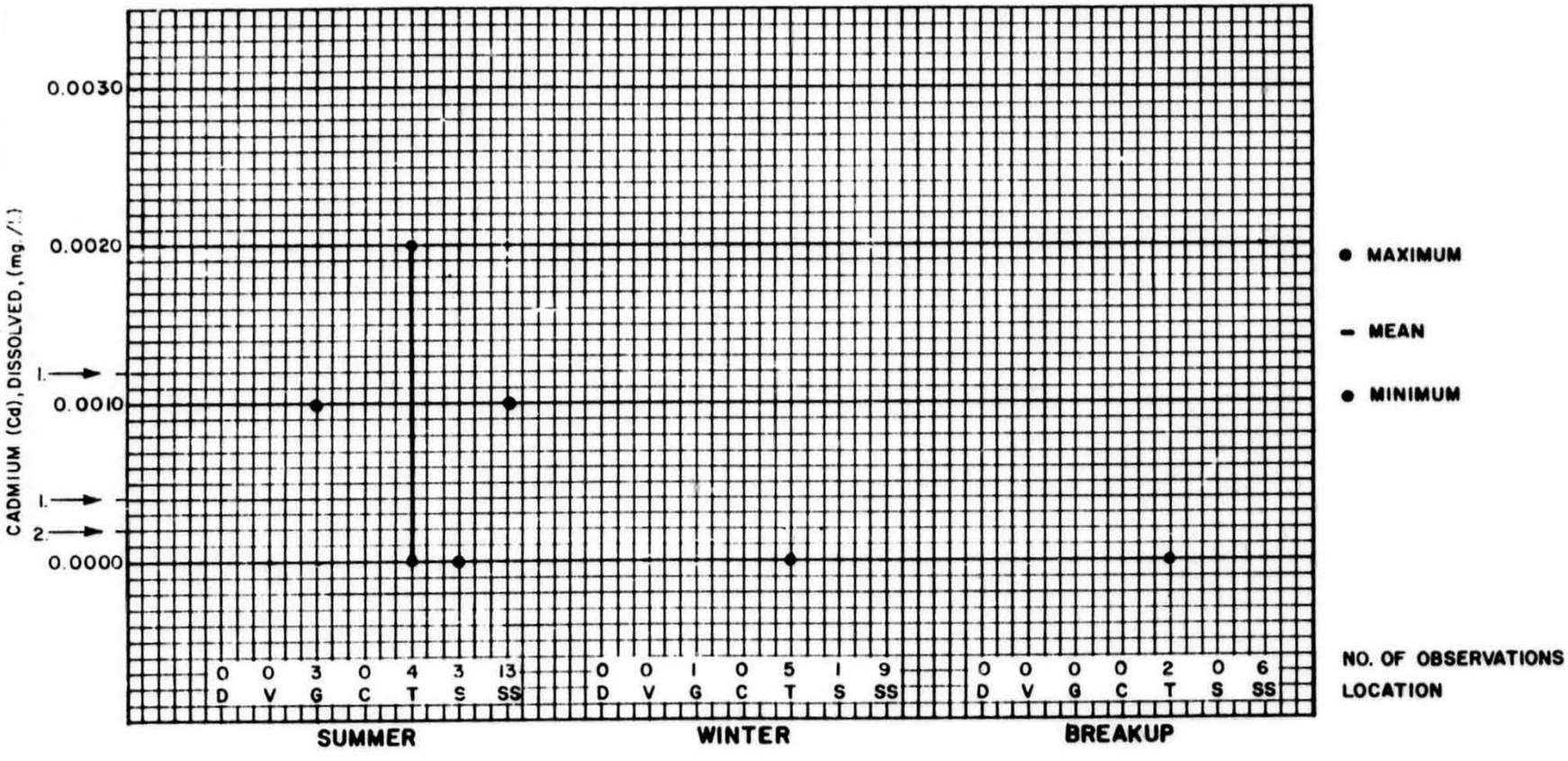

NOTES:

1. NO CRITERION ESTABLISHED.
2. A. EPA HAS SUGGESTED AN AMBIENT LIMIT OF 0.0035 mg./l. (SITTIG 1981).
2. B. THIS SUGGESTED LIMIT FOR BISMUTH IS BASED ON HUMAN HEALTH EFFECTS.
3. AT VEE CANYON, 9 SUMMER OBSERVATIONS, THE 3 WINTER OBSERVATIONS, AND THE 1 BREAKUP OBSERVATION WERE LESS THAN 0.05 mg./l.
4. AT GOLD CREEK, 6 SUMMER OBSERVATIONS, 2 WINTER OBSERVATIONS, AND THE 2 BREAKUP OBSERVATIONS WERE LESS THAN 0.05 mg./l.
5. (d) = DISSOLVED.

SOURCE: R&M

## DATA SUMMARY-BISMUTH (d)

FIGURE E.2.106




D-DENALI V-VEE CANYON G-GOLD CREEK C-CHULITNA T-TALKEETNA S-SUNSHINE SS-SUSITNA STATION

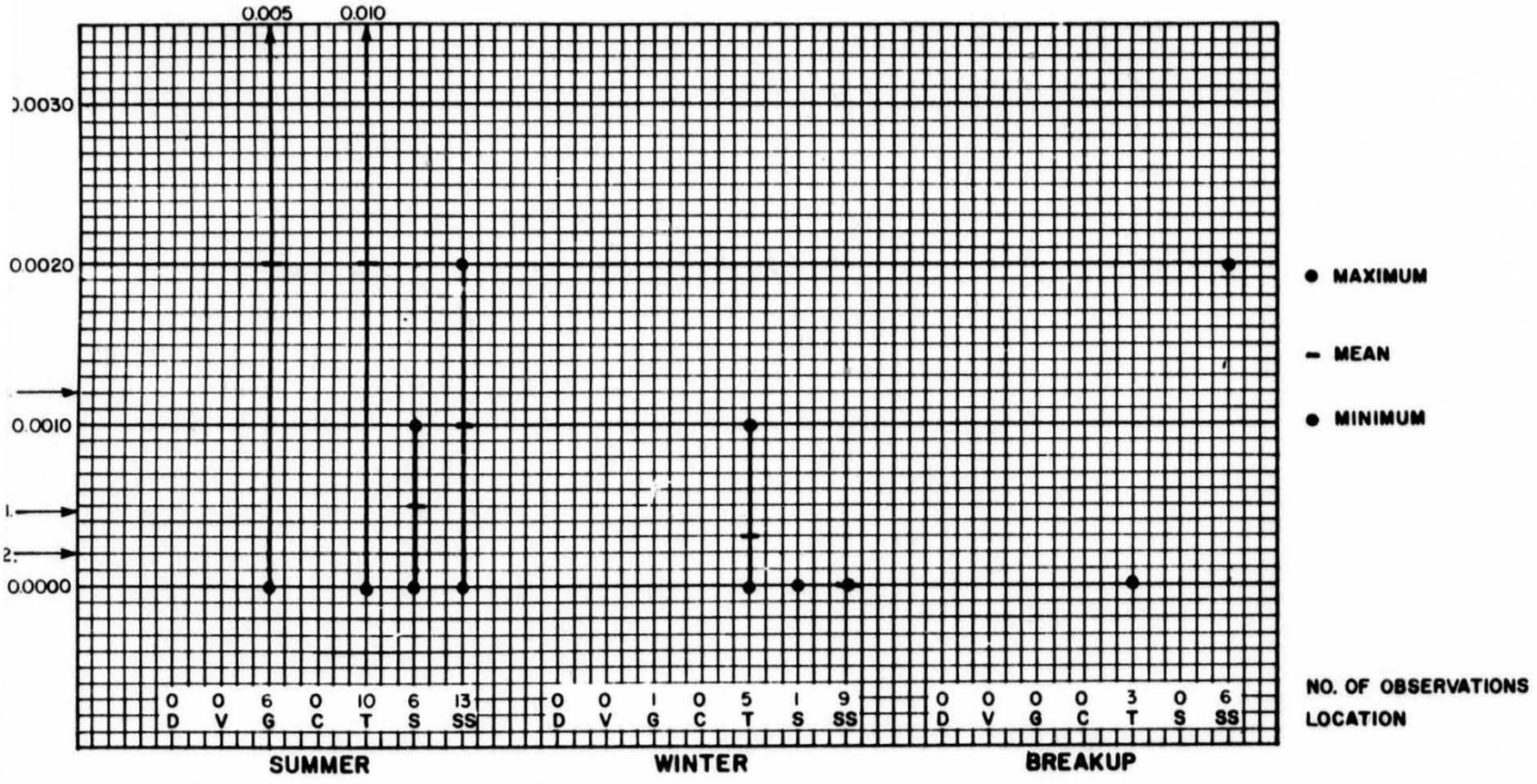
NOTES:

1. CRITERIA: 0.0012 mg/l IN HARD WATER AND 0.0004 SOFT WATER (EPA 1976).
2. CRITERION LESS THAN 0.0002 mg./l. (McNEELY et al. 1979).
3. THE ABOVE CRITERIA ESTABLISHED TO PROTECT FRESHWATER AQUATIC ORGANISMS.
4. AT GOLD CREEK, I SUMMER OBSERVATION WAS LESS THAN 0.001 mg./l. THE I WINTER OBSERVATION WAS LESS THAN 0.003 mg./l.
5. AT TALKEETNA, 2 SUMMER OBSERVATIONS AND 2 WINTER OBSERVATIONS WERE LESS THAN 0.001 mg./l.
6. AT SUNSHINE, 2 SUMMER OBSERVATIONS AND THE I WINTER OBSERVATION WERE LESS THAN 0.001 mg./l.
7. AT SUSITNA STATION, 12 SUMMER OBSERVATIONS WERE LESS THAN 0.002 mg./l. THE 9 WINTER OBSERVATIONS AND THE 6 BREAKUP OBSERVATIONS WERE LESS THAN 0.003 mg./l.
8. (d) = DISSOLVED

## DATA SUMMARY - CADMIUM (d)

SOURCE: USGS

FIGURE E.2.107




TES

CRITERIA 0.0012 IN HARD WATER AND 0.0004 mg/l IN SOFT WATER (EPA 1976).

CRITERION LESS THAN 0.0002 mg./l. (McNEELY et al. 1979).

ABOVE CRITERIA ESTABLISHED TO PROTECT FRESHWATER AQUATIC ORGANISMS.

AT GOLD CREEK, 3 SUMMER OBSERVATIONS WERE LESS THAN 0.010 mg/l. THE 1 WINTER OBSERVATION WAS LESS THAN 0.001 mg./l.

5 AT TALKEETNA, 5 SUMMER OBSERVATIONS, 1 WINTER OBSERVATION AND 2 BREAKUP OBSERVATIONS WERE LESS THAN 0.010 mg./l.

6 AT SUNSHINE, 4 SUMMER OBSERVATIONS WERE LESS THAN 0.010 mg/l

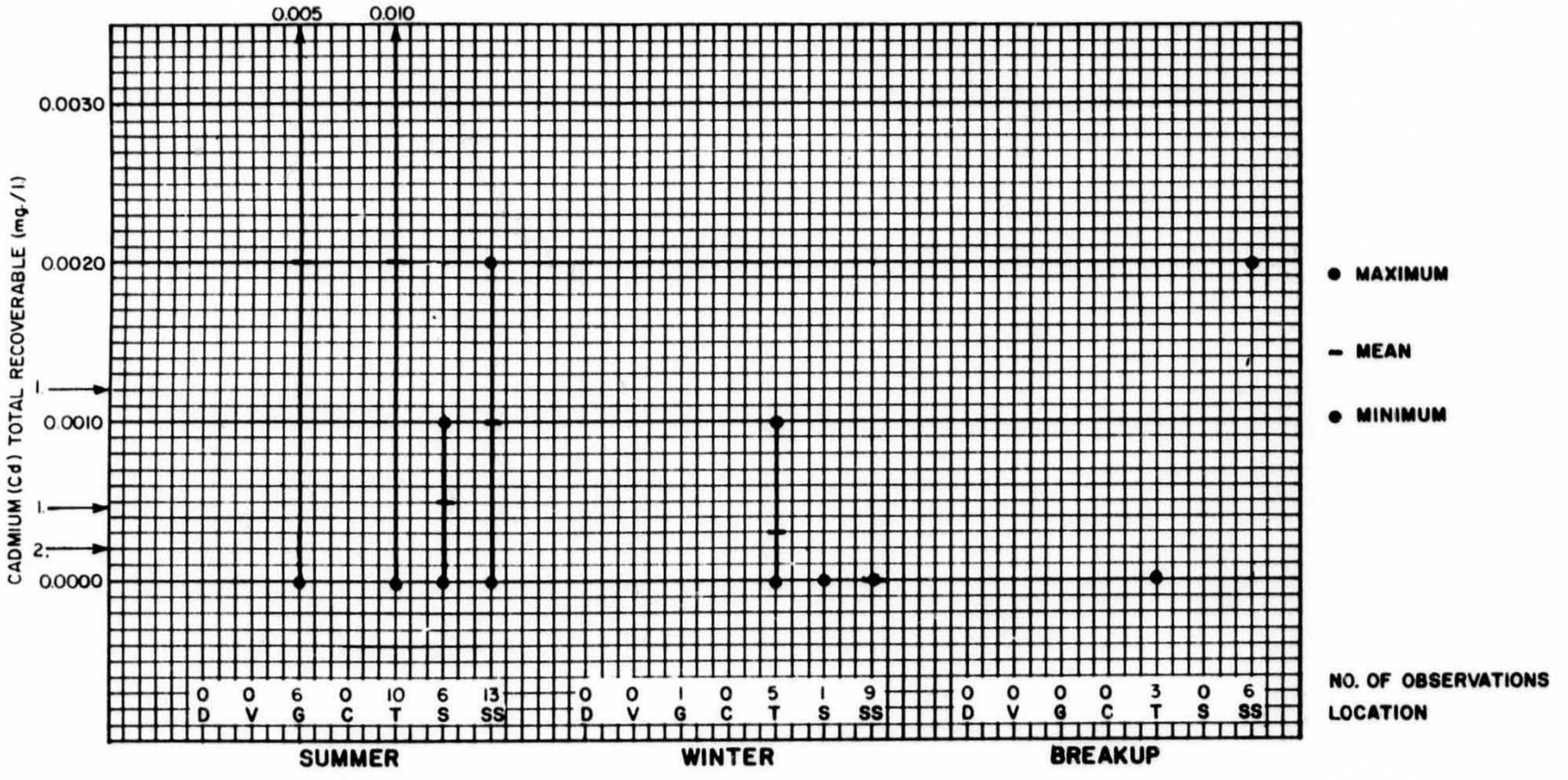
7 AT SUSITNA STATION, 7 SUMMER OBSERVATIONS, 7 WINTER OBSERVATIONS AND 5 BREAKUP OBSERVATIONS WERE LESS THAN 0.020 mg/l

8 (t) = TOTAL RECOVERABLE

# DATA SUMMARY - CADMIUM (t)

USGS

FIGURE E.2.108




D-DENALI V-VEE CANYON G-GOLD CREEK C-CHULITNA T-TALKEETNA S-SUNSHINE SS-SUSITNA STATION

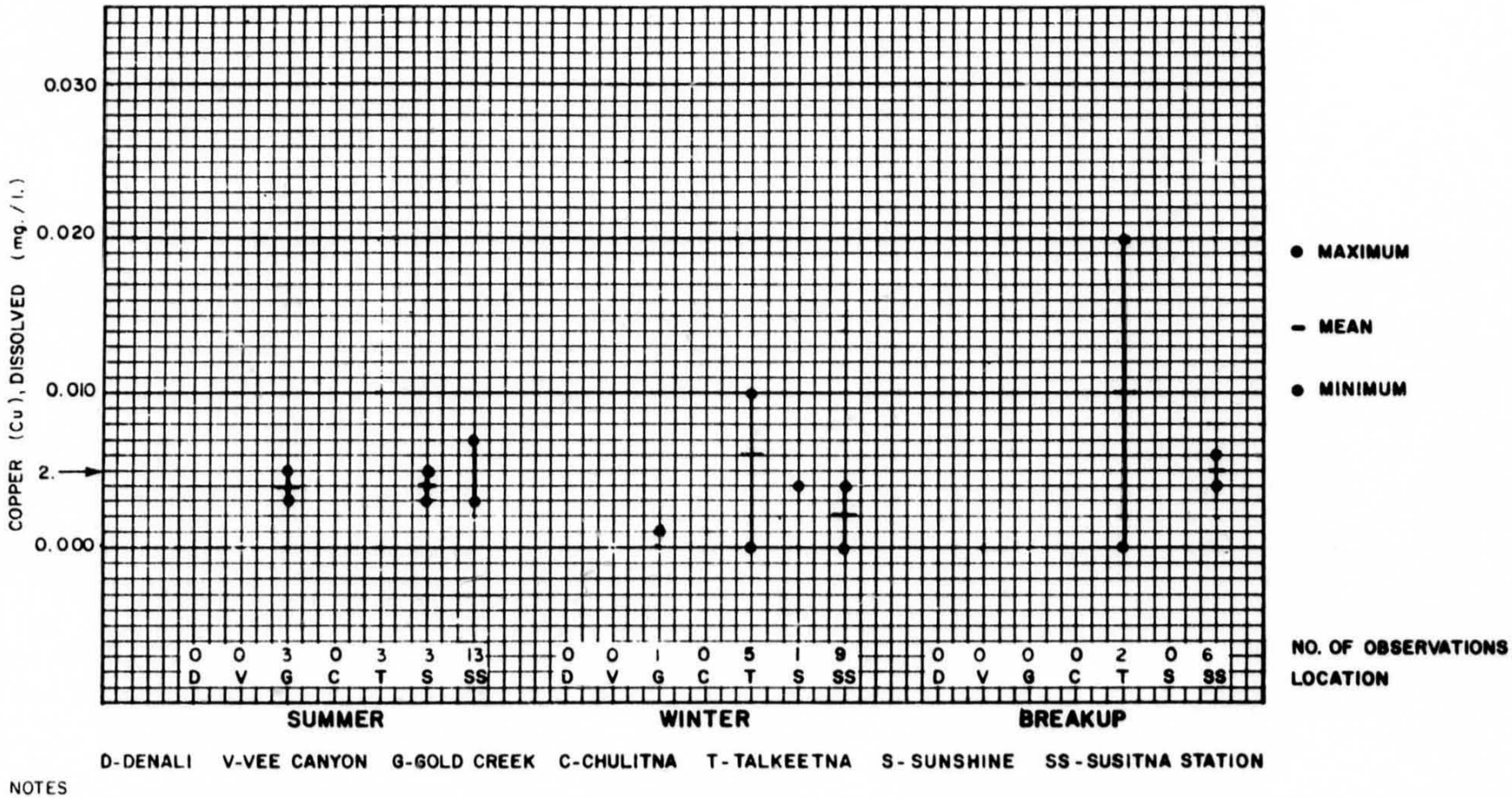
NOTES

1. CRITERIA 0.0012 IN HARD WATER AND 0.0004 mg/l IN SOFT WATER (EPA 1976).
2. CRITERION LESS THAN 0.0002 mg./l. (McNEELY et al. 1979).
3. ABOVE CRITERIA ESTABLISHED TO PROTECT FRESHWATER AQUATIC ORGANISMS.
4. AT GOLD CREEK, 3 SUMMER OBSERVATIONS WERE LESS THAN 0.010 mg/l. THE 1 WINTER OBSERVATION WAS LESS THAN 0.001 mg./l.
5. AT TALKEETNA, 5 SUMMER OBSERVATIONS, 1 WINTER OBSERVATION AND 2 BREAKUP OBSERVATIONS WERE LESS THAN 0.010 mg./l.
6. AT SUNSHINE, 4 SUMMER OBSERVATIONS WERE LESS THAN 0.010 mg./l
7. AT SUSITNA STATION, 7 SUMMER OBSERVATIONS, 7 WINTER OBSERVATIONS AND 5 BREAKUP OBSERVATIONS WERE LESS THAN 0.020 mg/l
8. (t) = TOTAL RECOVERABLE

## DATA SUMMARY - CADMIUM (t)

SOURCE: USGS

FIGURE E.2.108




D-DENALI V-VEE CANYON G-GOLD CREEK C-CHULITNA T-TALKEETNA S-SUNSHINE SS-SUSITNA STATION

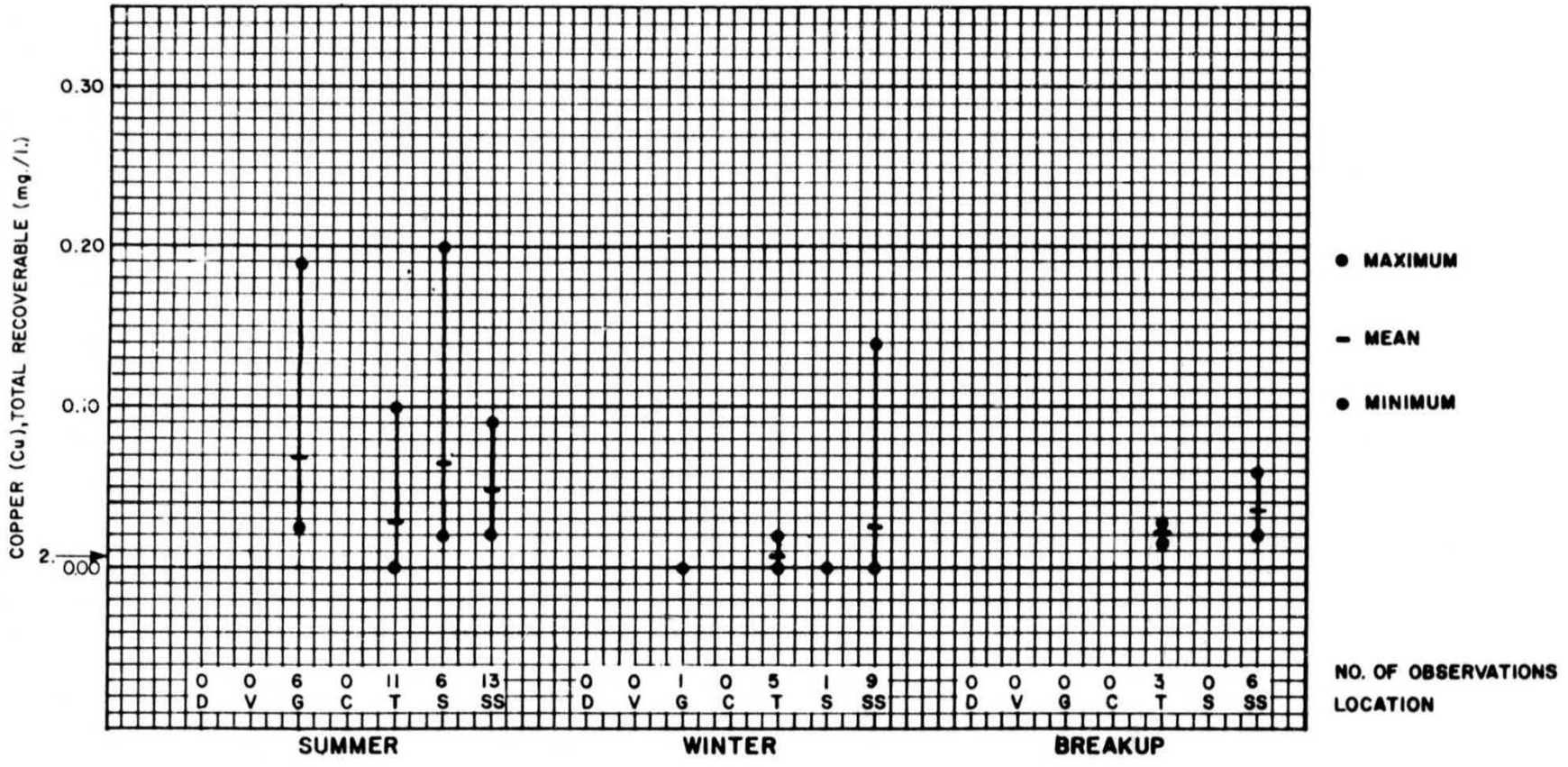
NOTES

1. CRITERION: 0.01 OF THE 96-HOUR $LC_{50}$ DETERMINED THROUGH BIOASSAY (EPA 1976).
2. CRITERION. 0.005 mg/l (McNEELY et al. 1979).
3. THE ABOVE CRITERIA ESTABLISHED TO PROTECT FRESHWATER AQUATIC ORGANISMS.
4. AT TALKEETNA, THE 3 SUMMER OBSERVATIONS WERE LESS THAN 0.010 mg/l.
5. AT SUSITNA STATION, 6 SUMMER OBSERVATIONS, 2 WINTER OBSERVATIONS AND 2 BREAKUP OBSERVATIONS WERE LESS THAN 0.002 mg/l.
6. (d) = DISSOLVED

# DATA SUMMARY COPPER (d)

SOURCE: USGS

FIGURE E.2.109



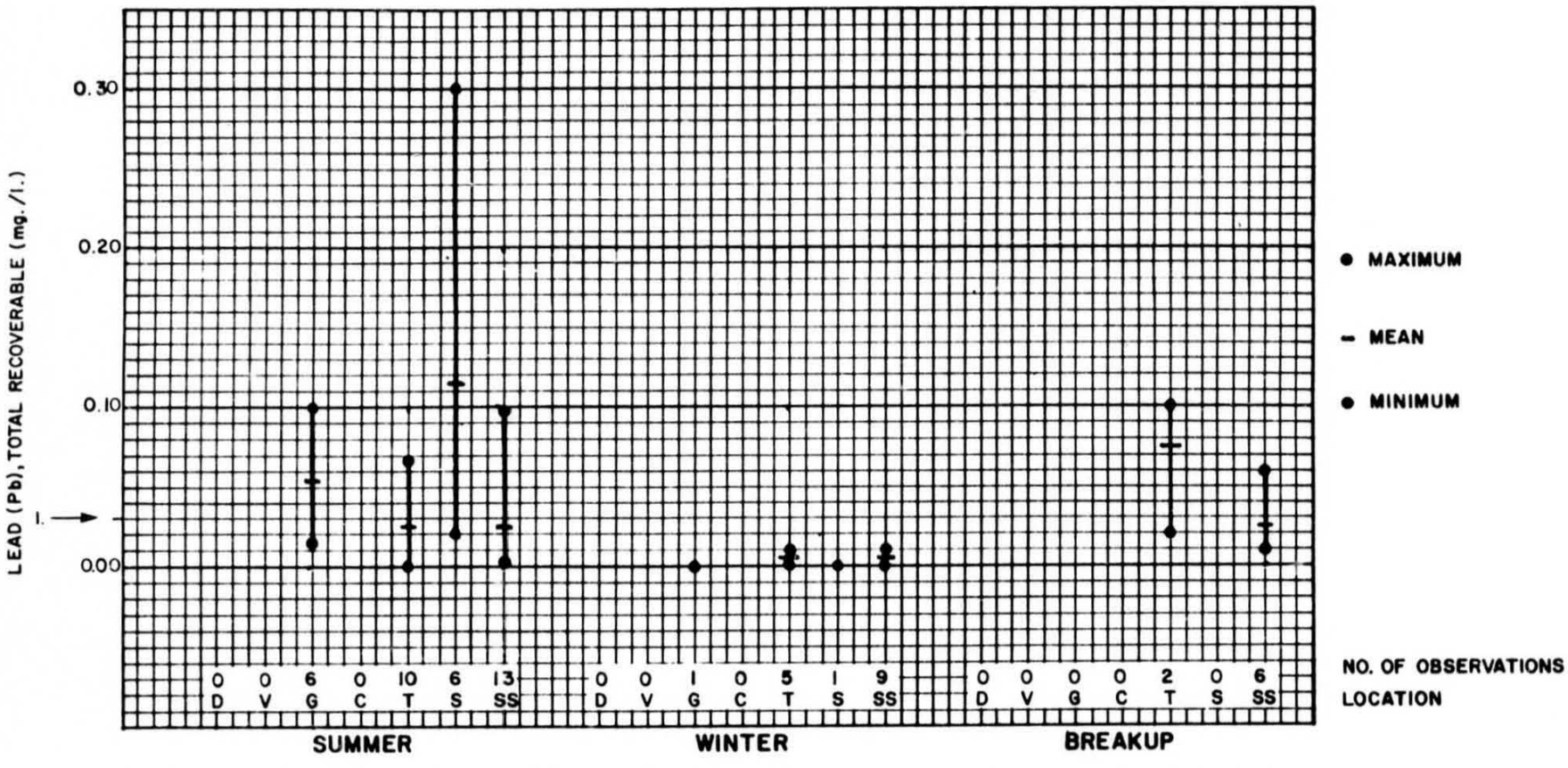

NOTES:

1. CRITERION: 0.01 OF THE 96-HOUR $LC_{50}$ DETERMINED THROUGH BIOASSAY (EPA 1976).
2. CRITERION: 0.005 mg./l. (McNEELY et al. 1979).
3. THE ABOVE CRITERIA ESTABLISHED TO PROTECT FRESHWATER AQUATIC ORGANISMS.
4. AT GOLD CREEK, 1 SUMMER OBSERVATION WAS LESS THAN 0.010 mg./l.
5. AT SUSITNA STATION, 1 SUMMER OBSERVATION AND 2 WINTER OBSERVATIONS WERE LESS THAN 0.020 mg./l.
6. AT TALKEETNA, 1 BREAKUP OBSERVATION WAS LESS THAN 0.020 mg./l.
7. (t) = TOTAL RECOVERABLE.

SOURCE USGS

# DATA SUMMARY-COPPER (t)

FIGURE E.2.110



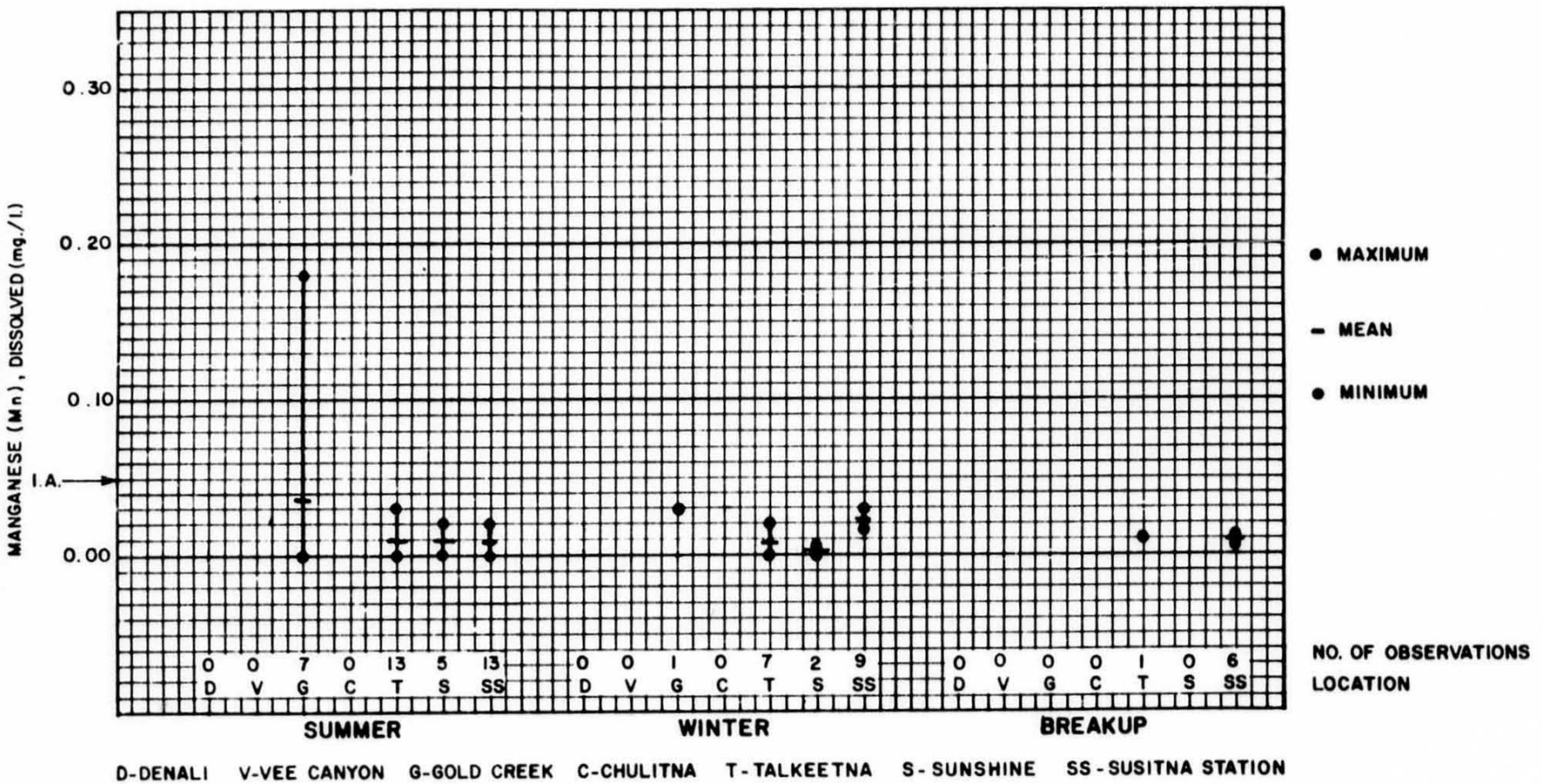

NOTES:

1. CRITERION: LESS THAN 0.03 mg./l. (McNEELY et al. 1979).
2. CRITERION: 0.01 OF THE 96-HOUR $LC_{50}$ DETERMINED BY BIOASSAY (EPA 1976).
3. ABOVE CRITERIA ESTABLISHED TO PROTECT FRESHWATER AQUATIC ORGANISMS.
4. AT GOLD CREEK, 3 SUMMER OBSERVATIONS WERE LESS THAN 0.100 mg./l.
5. AT TALKEETNA, 6 SUMMER OBSERVATIONS AND 1 WINTER OBSERVATION WERE LESS THAN 0.100 mg./l.
6. AT SUNSHINE, 2 SUMMER OBSERVATIONS WERE LESS THAN 0.100 mg./l.
7. AT SUSITNA STATION, 5 SUMMER OBSERVATIONS, 3 WINTER OBSERVATIONS, AND 2 BREAKUP OBSERVATIONS WERE LESS THAN 0.200 mg./l.
8. (t) = TOTAL RECOVERABLE.

SOURCE: USGS

## DATA SUMMARY - LEAD (t)

FIGURE E.2.112




NOTES:

I.A CRITERION: LESS THAN 0.05 mg./l. (EPA 1976)

I.B. ESTABLISHED TO PROTECT WATER SUPPLIES.

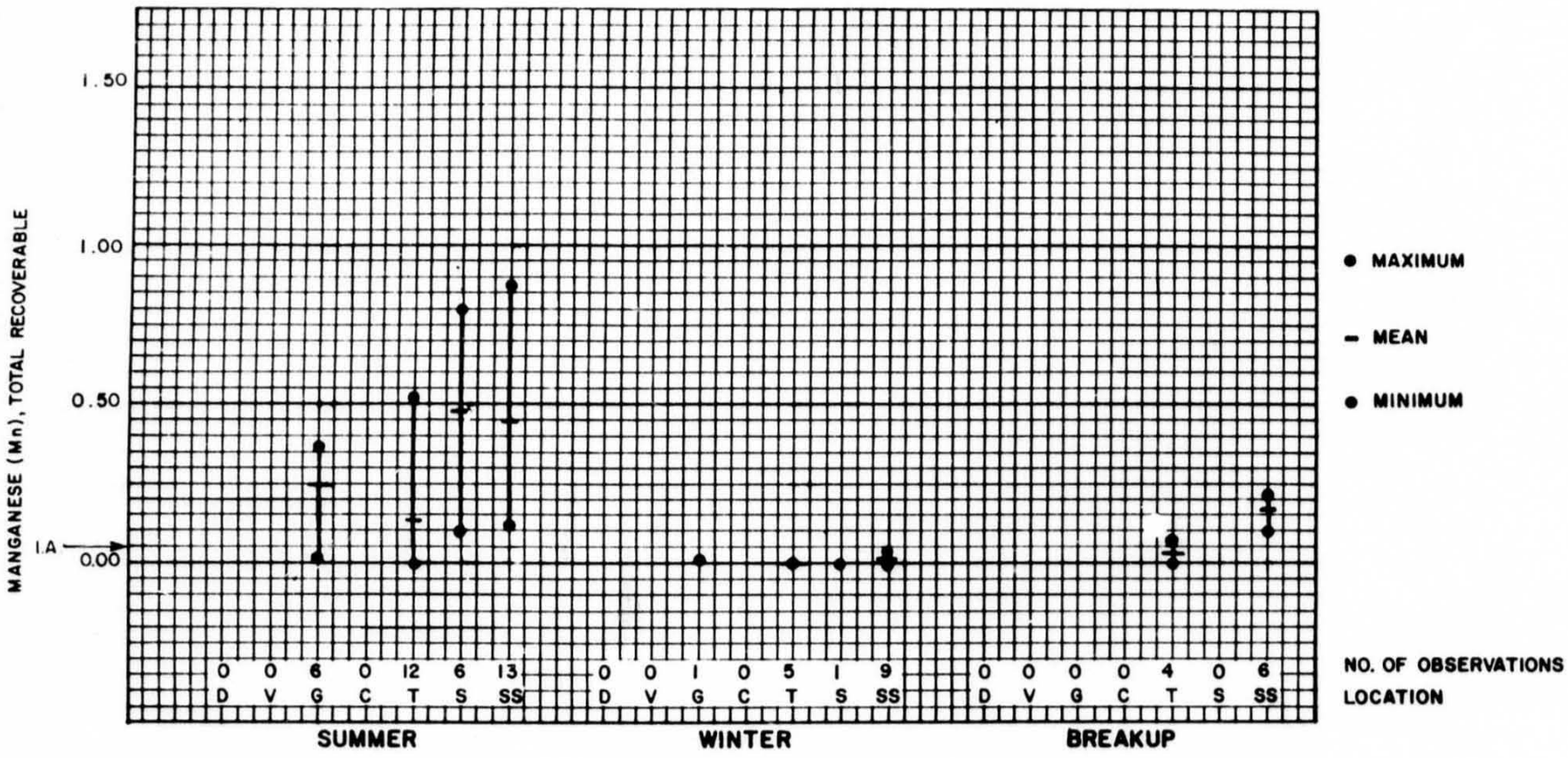
2. AT SUSITNA STATION, 6 SUMMER OBSERVATIONS, 1 WINTER OBSERVATION AND 6 BREAKUP OBSERVATIONS WERE LESS THAN 0.010 mg./l.

3. (d) = DISSOLVED

## DATA SUMMARY - MANGANESE (d)

SOURCE: USGS

FIGURE E.2.113




D-DENALI V-VEE CANYON G-GOLD CREEK C-CHULITNA T-TALKEETNA S-SUNSHINE SS-SUSITNA STATION

NOTES:

I.A. CRITERION: LESS THAN 0.05 mg./l. (EPA 1976).

I.B. ESTABLISHED TO PROTECT WATER SUPPLIES.

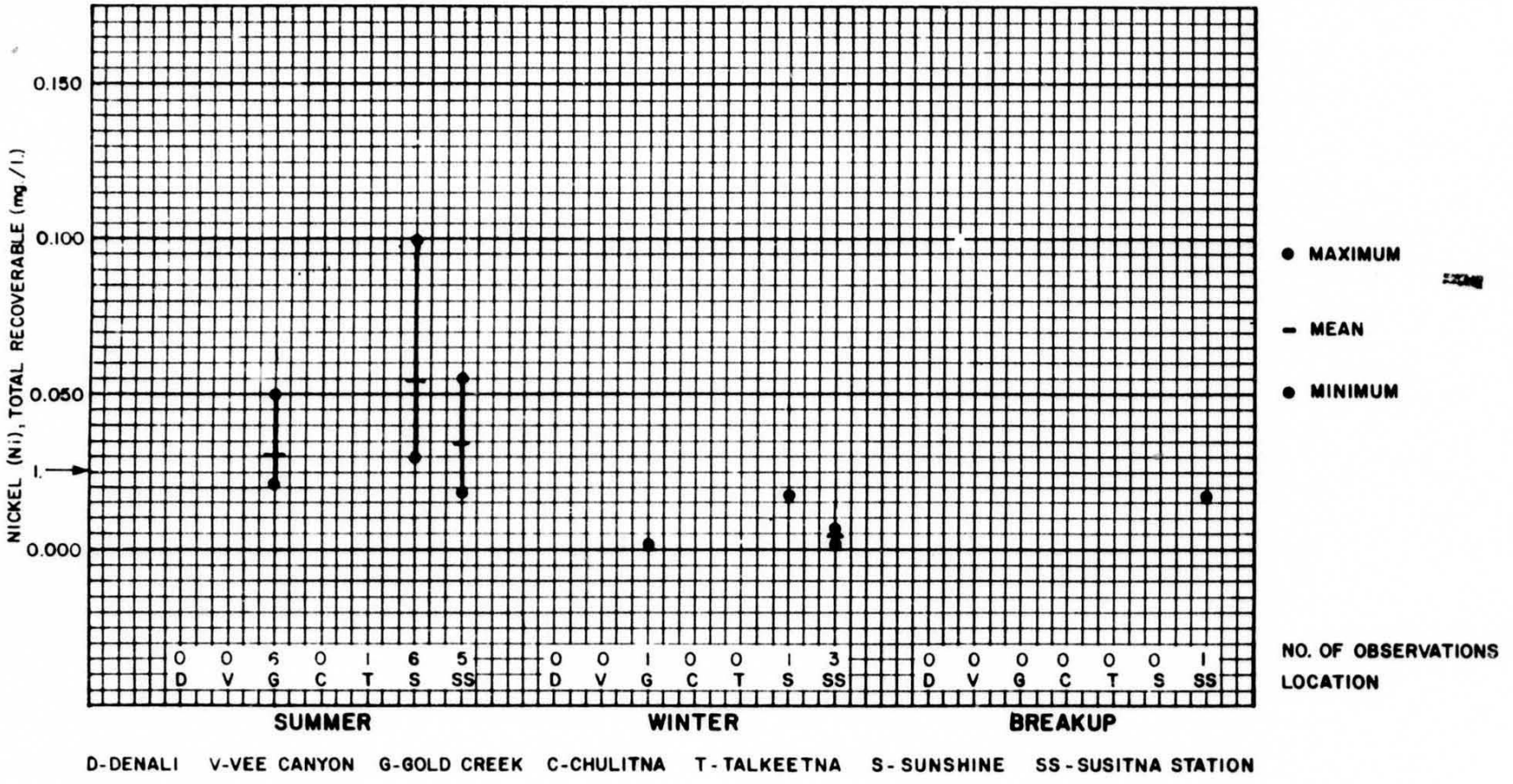
2. AT SUSITNA STATION, 1 BREAKUP OBSERVATION WAS LESS THAN 0.01 mg./l.

3. (t) = TOTAL RECOVERABLE.

## DATA SUMMARY - MANGANESE (t)

SOURCE: USGS

FIGURE E.2.114



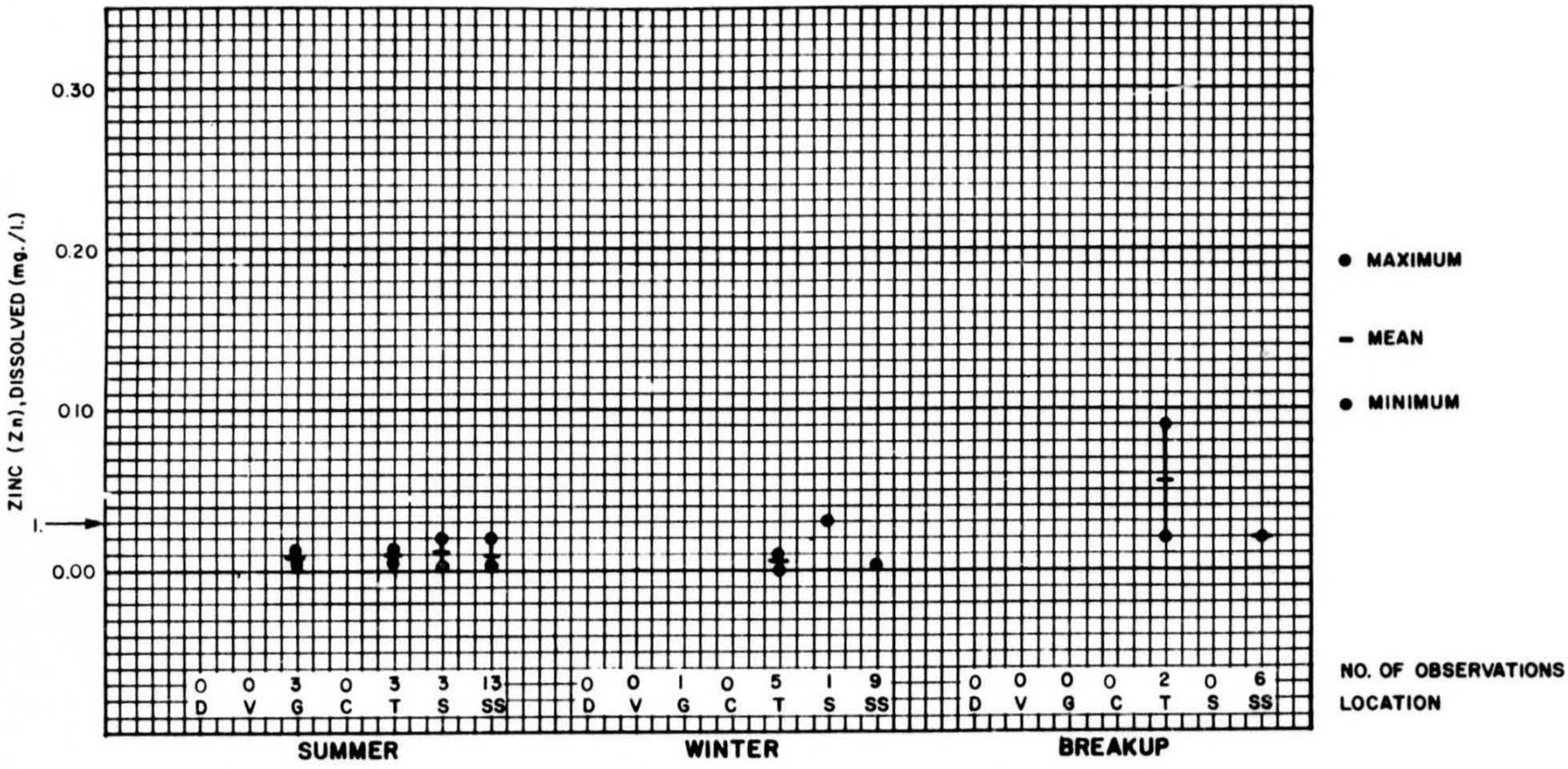

NOTES:

1. CRITERION: LESS THAN 0.025 mg./l. (McNEELY et al. 1979).
2. CRITERION: 0.01 OF THE 96-HOUR $LC_{50}$ DETERMINED THROUGH BIOASSAY (EPA 1976).
3. THE ABOVE CRITERIA ESTABLISHED TO PROTECT FRESHWATER AQUATIC ORGANISMS.
4. AT GOLD CREEK, 2 SUMMER OBSERVATIONS WERE LESS THAN 0.05 mg./l.
5. AT TALKEETNA, THE 1 SUMMER OBSERVATION WAS LESS THAN 0.05 mg./l.
6. AT SUNSHINE, 2 SUMMER OBSERVATIONS WERE LESS THAN 0.05 mg./l.
7. (t) = TOTAL RECOVERABLE.

SOURCE: USGS

## DATA SUMMARY- NICKEL (t)

FIGURE E.2.117



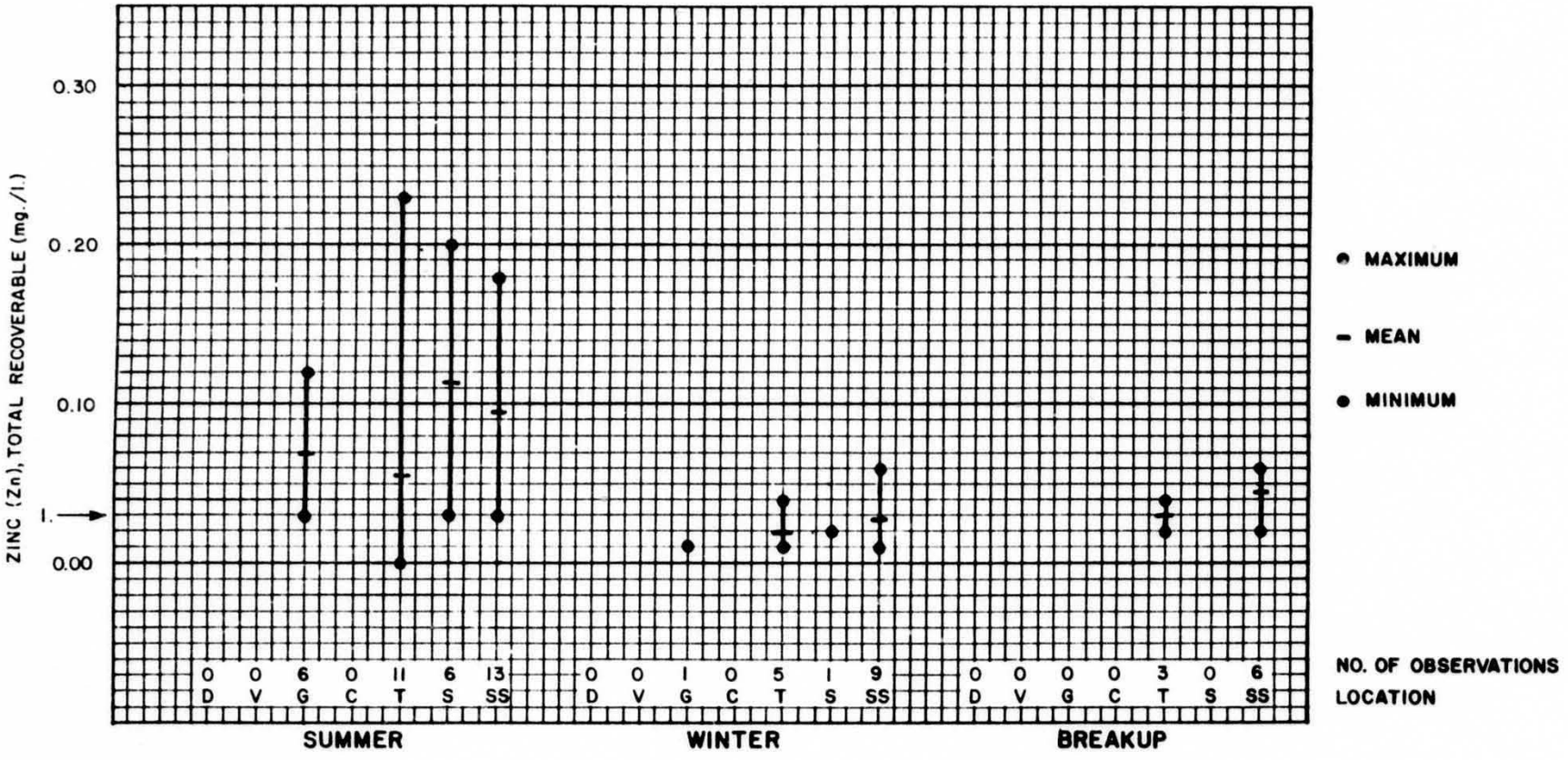

NOTES:

1. CRITERION: LESS THAN 0.03 mg./l. (McNEELY et al. 1979).
2. CRITERION: 0.01 OF THE 96-HOUR $LC_{50}$ DETERMINED THROUGH BIOASSY (EPA 1976).
3. THE ABOVE CRITERIA BASED ON HUMAN HEALTH EFFECTS.
4. AT SUSITNA STATION, 8 SUMMER OBSERVATIONS, 8 WINTER OBSERVATIONS AND 4 BREAKUP OBSERVATIONS WERE LESS THAN 0.020 mg./l.
5. AT GOLD CREEK THE 1 WINTER OBSERVATION WAS LESS THAN 0.012 mg./l.
6. (d) = DISSOLVED

SOURCE: USGS

## DATA SUMMARY - ZINC (d)

FIGURE E.2.118




D-DENALI V-VEE CANYON G-GOLD CREEK C-CHULITNA T-TALKEETNA S-SUNSHINE SS-SUSITNA STATION

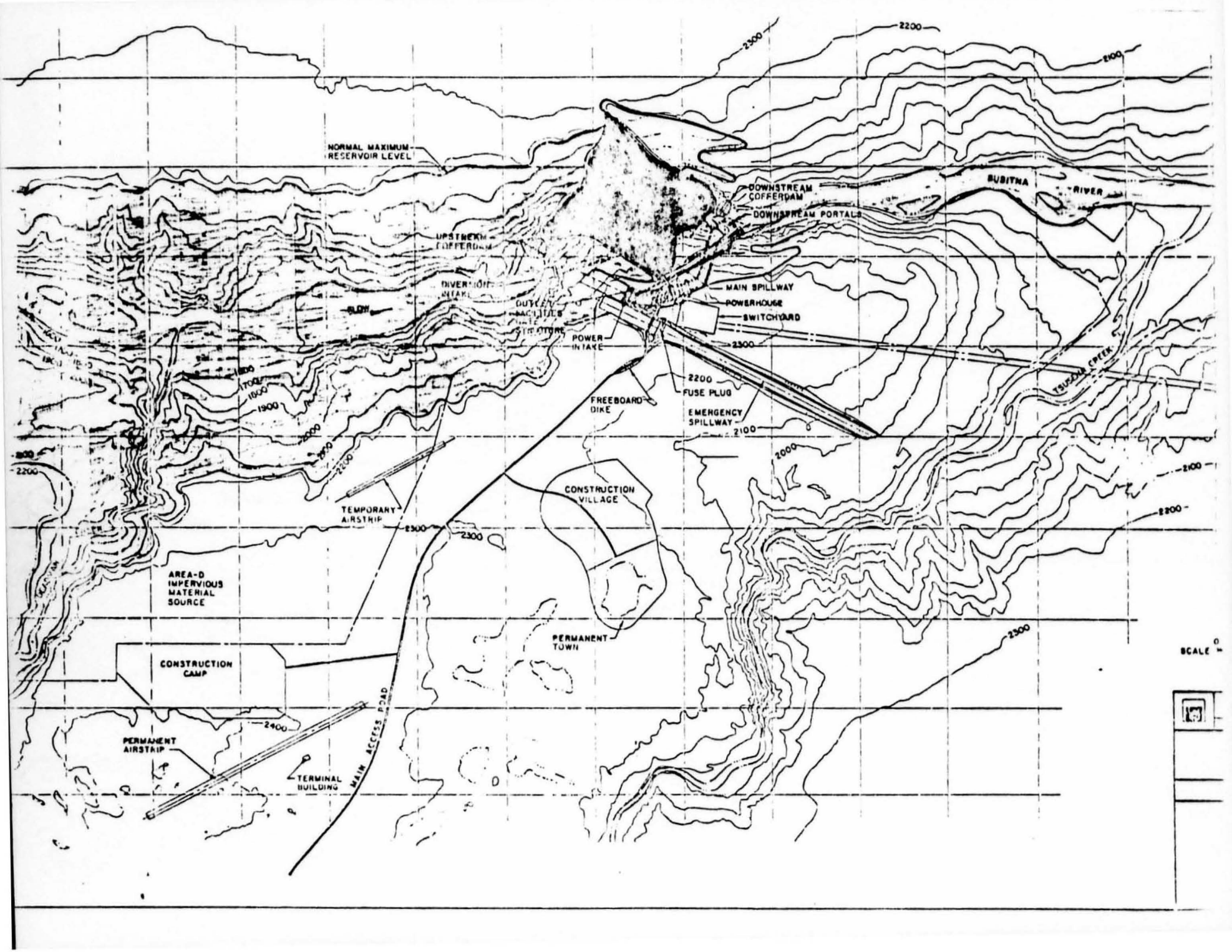
NOTES:

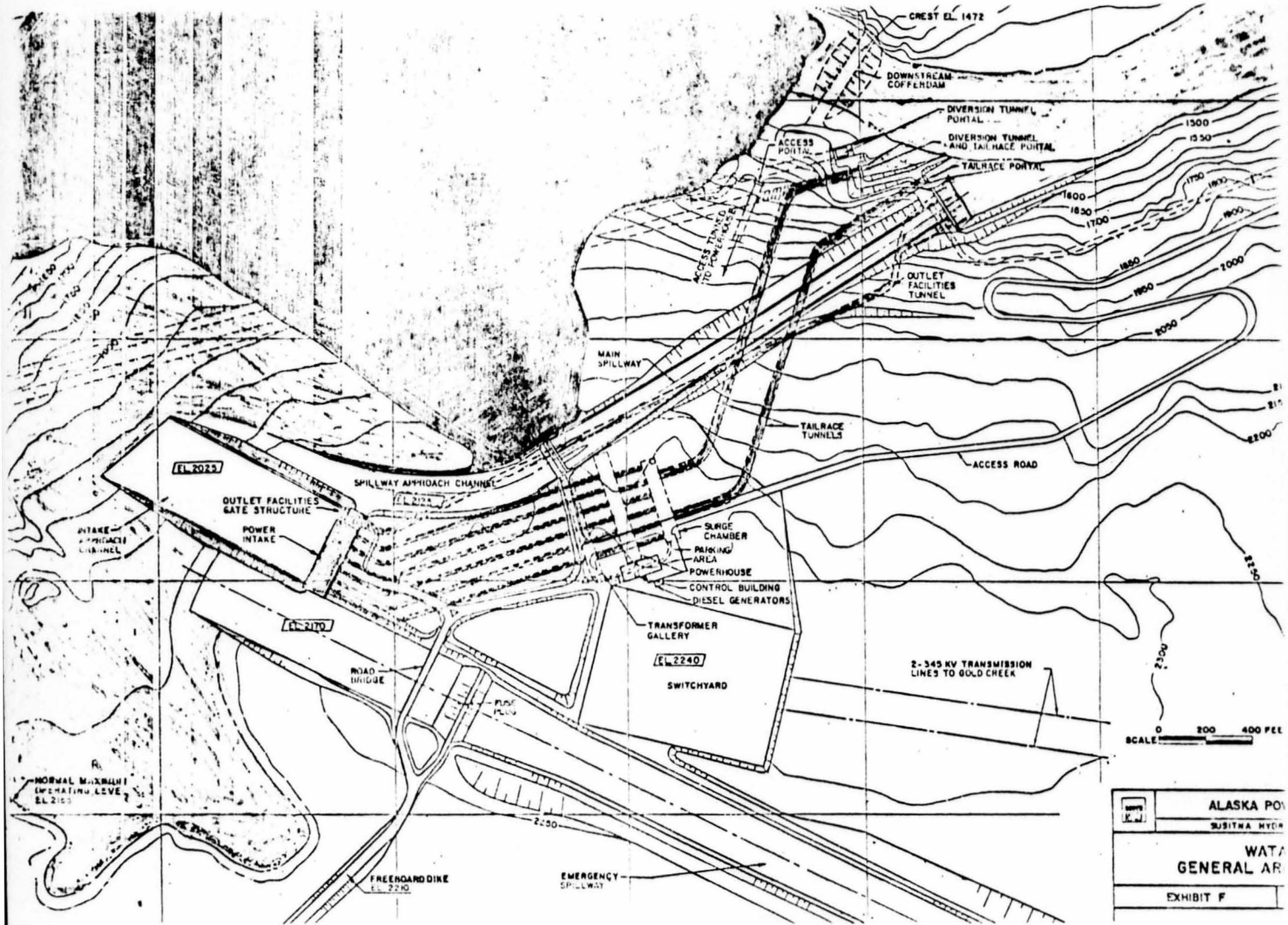
1. CRITERION: LESS THAN 0.03 mg./l. (McNEELY et al. 1979).
2. CRITERION: 0.01 OF THE 96-HOUR $LC_{50}$ DETERMINED THROUGH BIOASSAY (EPA 1976).
3. THE ABOVE CRITERIA ESTABLISHED TO PROTECT FRESHWATER AQUATIC ORGANISMS.
4. AT SUSITNA STATION, 1 SUMMER OBSERVATION AND 2 WINTER OBSERVATIONS WERE LESS THAN 0.020 mg./l.
5. (t) = TOTAL RECOVERABLE.

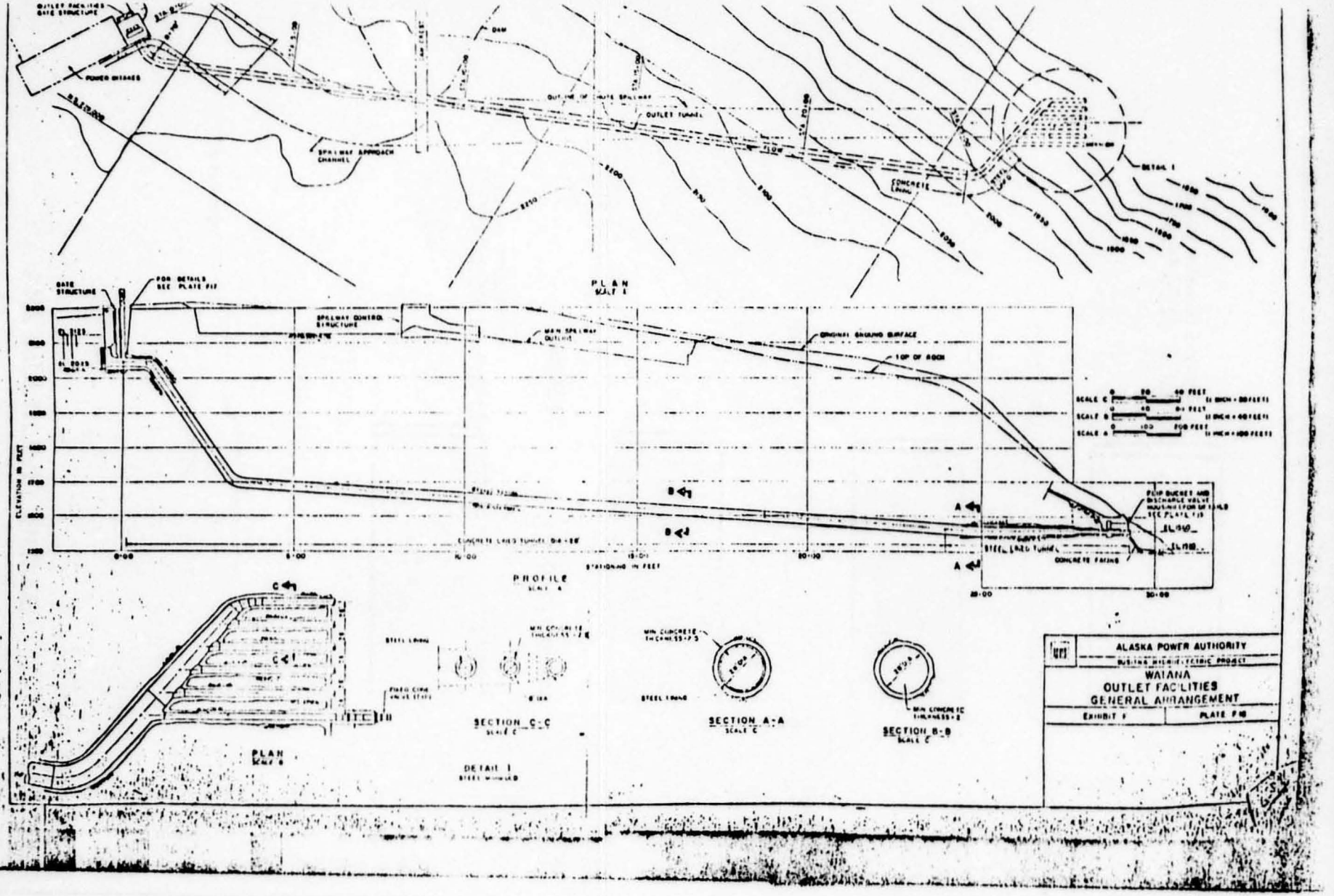
## DATA SUMMARY- ZINC (t)

SOURCE: USGS

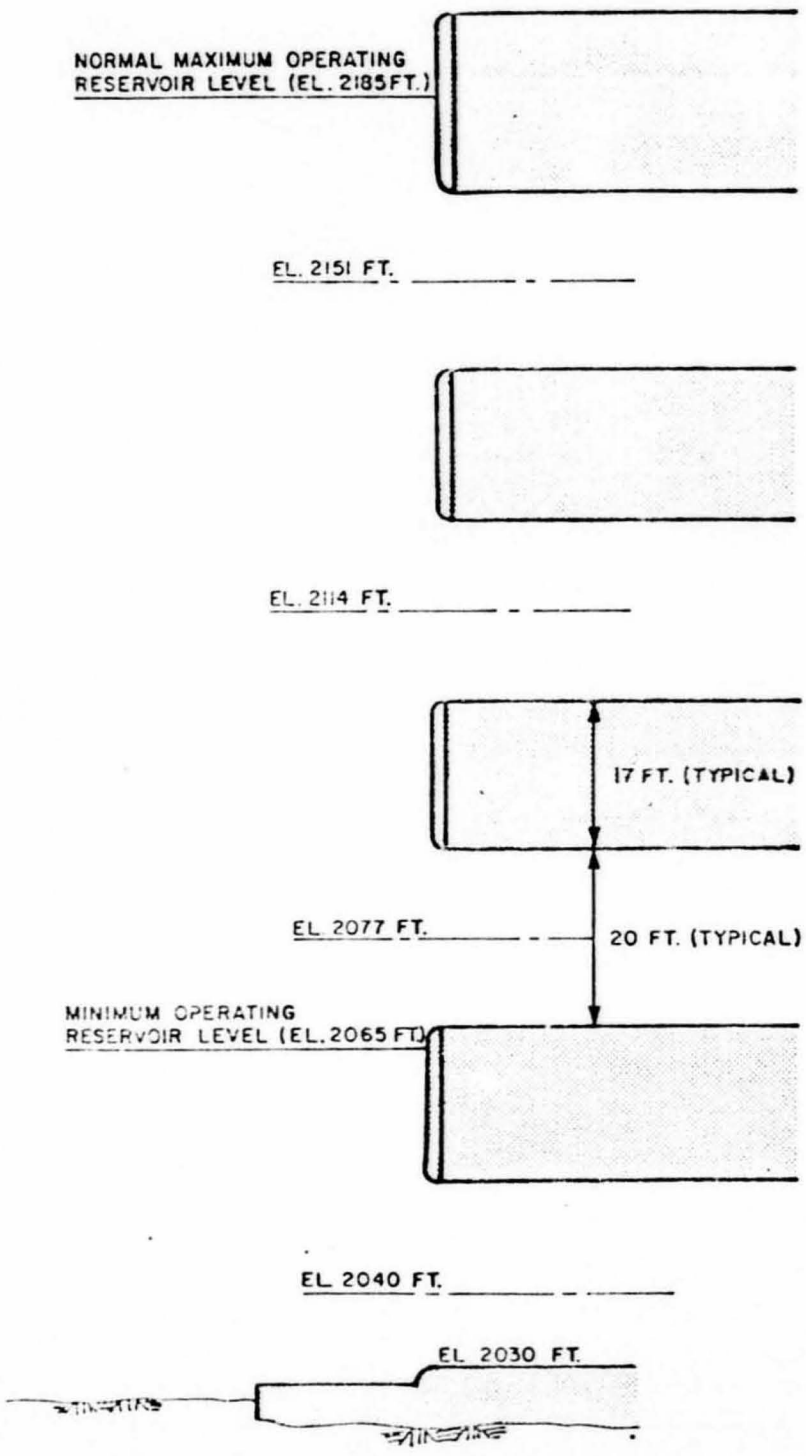
FIGURE E.2.119


NORMAL MAXIMUM RESERVOIR LEVEL
UPSTREAM COFFERDAM
DIVERSION INTAKE
OUTLET FACILITIES STRUCTURE
SLOW
DOWNSTREAM COFFERDAM
DOWNSTREAM PORTALS
SUSITNA
RIVER
MAIN SPILLWAY
POWERHOUSE
SWITCHYARD
POWER INTAKE
2300
2200
FUSE PLUG
FREEBOARD DIKE
EMERGENCY SPILLWAY
2100
TSUSENA CREEK
2000
1900
1800
1700
1600
2400
TEMPORARY AIRSTRIP
CONSTRUCTION VILLAGE
AREA-D IMPERVIOUS MATERIAL SOURCE
PERMANENT TOWN
CONSTRUCTION CAMP
PERMANENT AIRSTRIP
TERMINAL BUILDING
MAIN ACCESS ROAD
SCALE


CREST EL. 1472
DOWNSTREAM COFFERDAM
DIVERSION TUNNEL PORTAL
ACCESS PORTAL
DIVERSION TUNNEL AND TAILRACE PORTAL
TAILRACE PORTAL
ACCESS TUNNEL TO POWERHOUSE
OUTLET FACILITIES TUNNEL
MAIN SPILLWAY
TAILRACE TUNNELS
ACCESS ROAD
EL. 2025
SPILLWAY APPROACH CHANNEL
EL. 2124
OUTLET FACILITIES GATE STRUCTURE
POWER INTAKE
INTAKE APPROACH CHANNEL
SURGE CHAMBER
PARKING AREA
POWERHOUSE
CONTROL BUILDING
DIESEL GENERATORS
EL. 2170
TRANSFORMER GALLERY
EL. 2240
SWITCHYARD
ROAD BRIDGE
2-345 KV TRANSMISSION LINES TO GOLD CREEK
NORMAL MAXIMUM OPERATING LEVEL EL. 2185
2250
FREEBOARD DIKE EL. 2210
EMERGENCY SPILLWAY
1500
1550
1600
1650
1700
1750
1800
1850
1900
1950
2000
2050
2100
2150
2200
2250
2300
SCALE 0 200 400 FEE
ALASKA PO
SUSITNA HYDR
WAT
GENERAL AR
EXHIBIT F

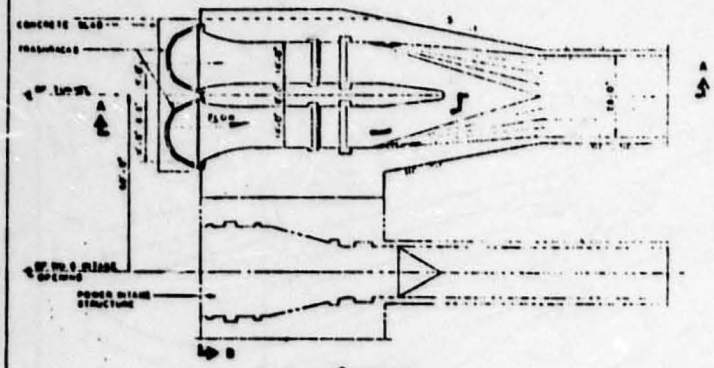

PLAN
PROFILE
SECTION C-C
SECTION A-A
SECTION B-B
DETAIL 1
PLAN
ALASKA POWER AUTHORITY
WAIANA
OUTLET FACILITIES
GENERAL ARRANGEMENT
EXHIBIT F
PLATE F10

[redacted]

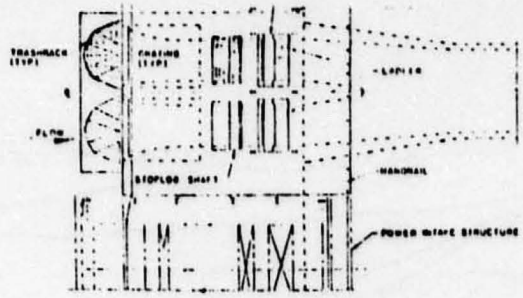



# WATANA MULTILEVEL INTAKE

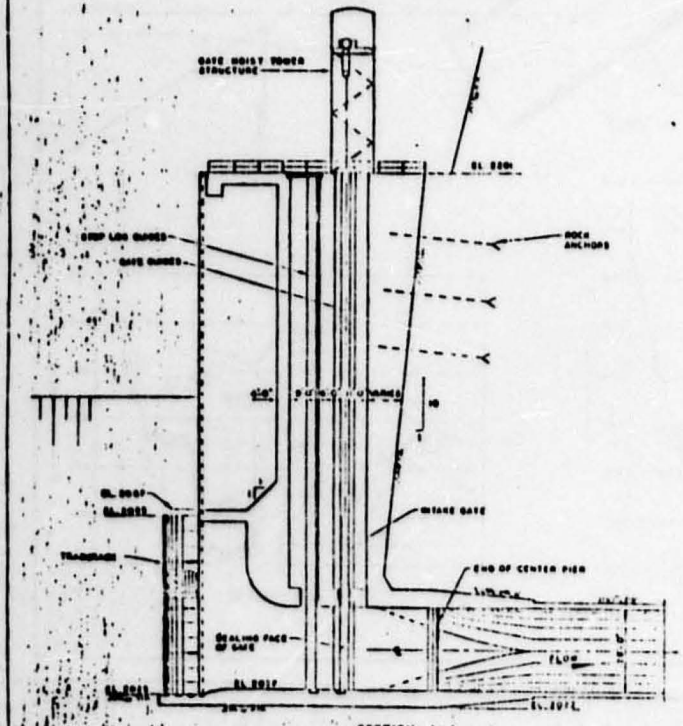
FIGURE E 2.169



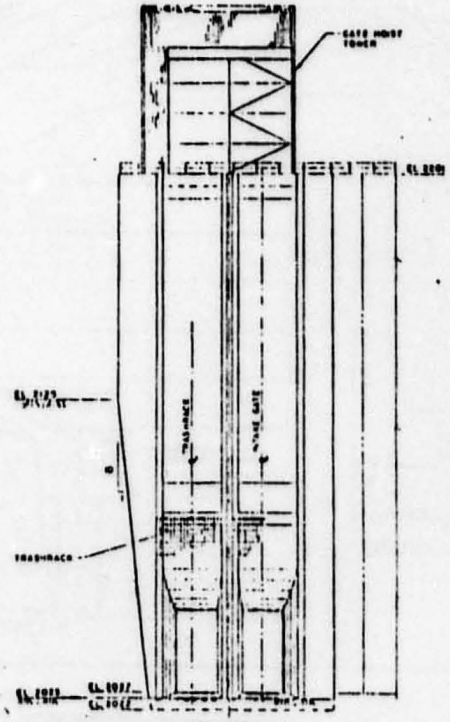

PLAN AT ℄ TUNNEL




PLAN AT EL. 2220




SECTION A-A



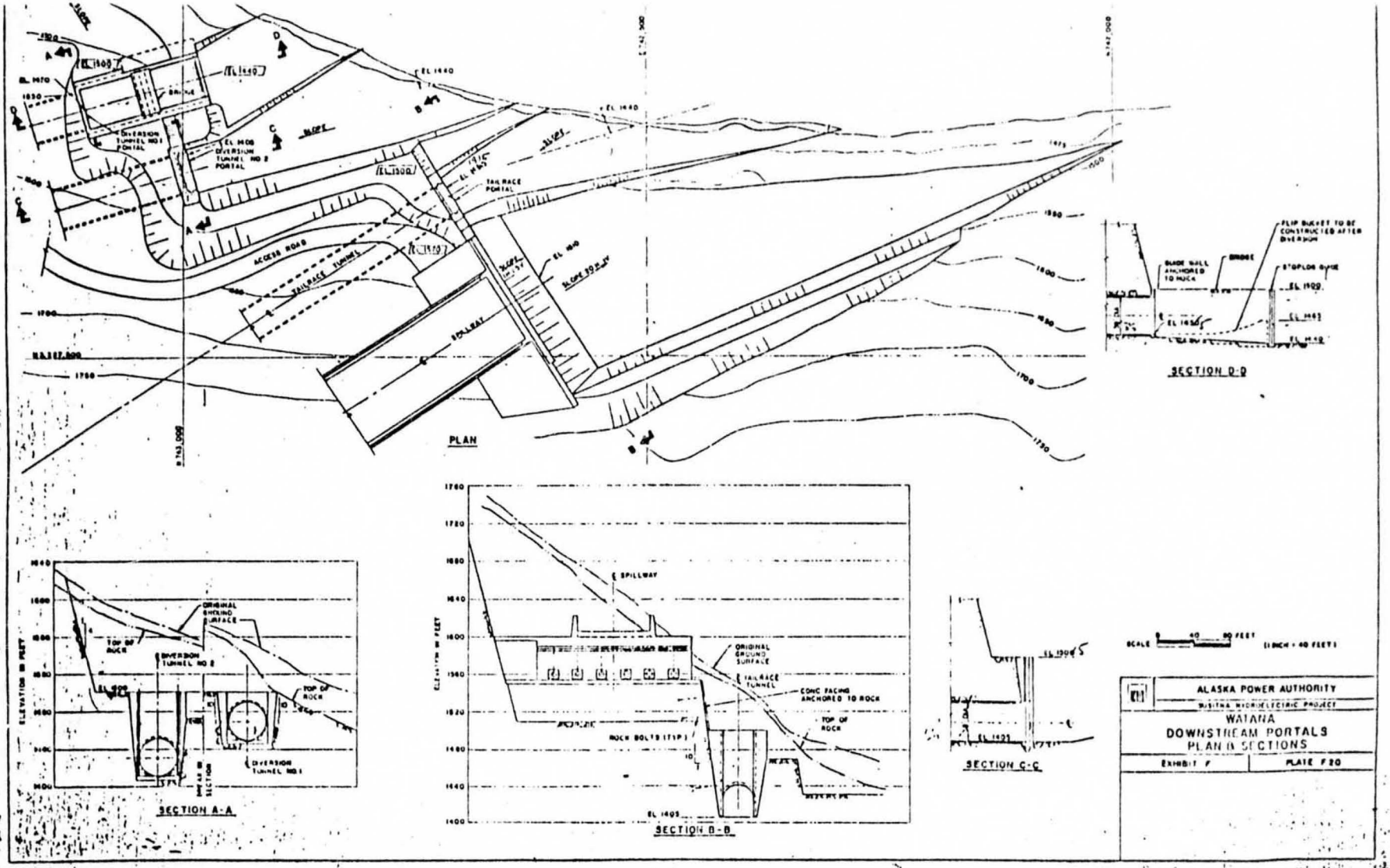

SECTION B-B

SCALE 0 10 30 FEET (1/16 INCH = 1 FEET)

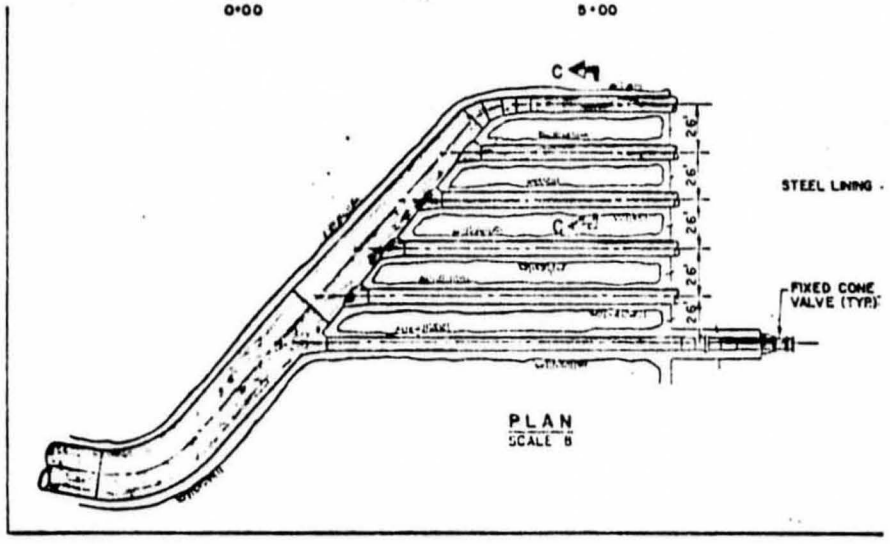
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

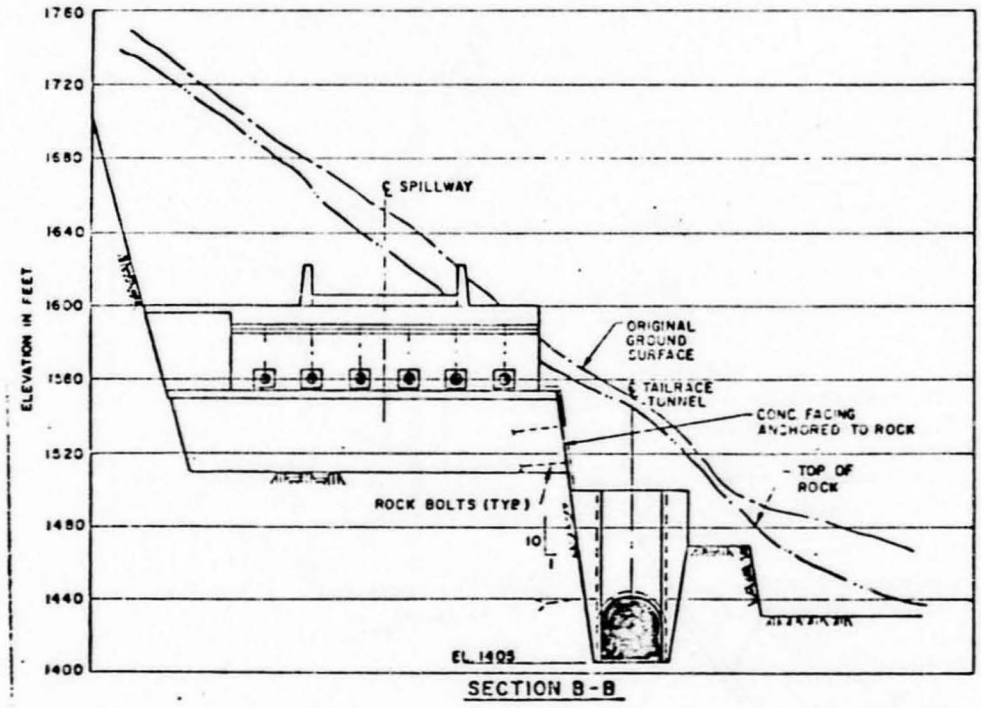
WATANA
OUTLET FACILITIES
GATE STRUCTURE

EXHIBIT F | PLATE F17

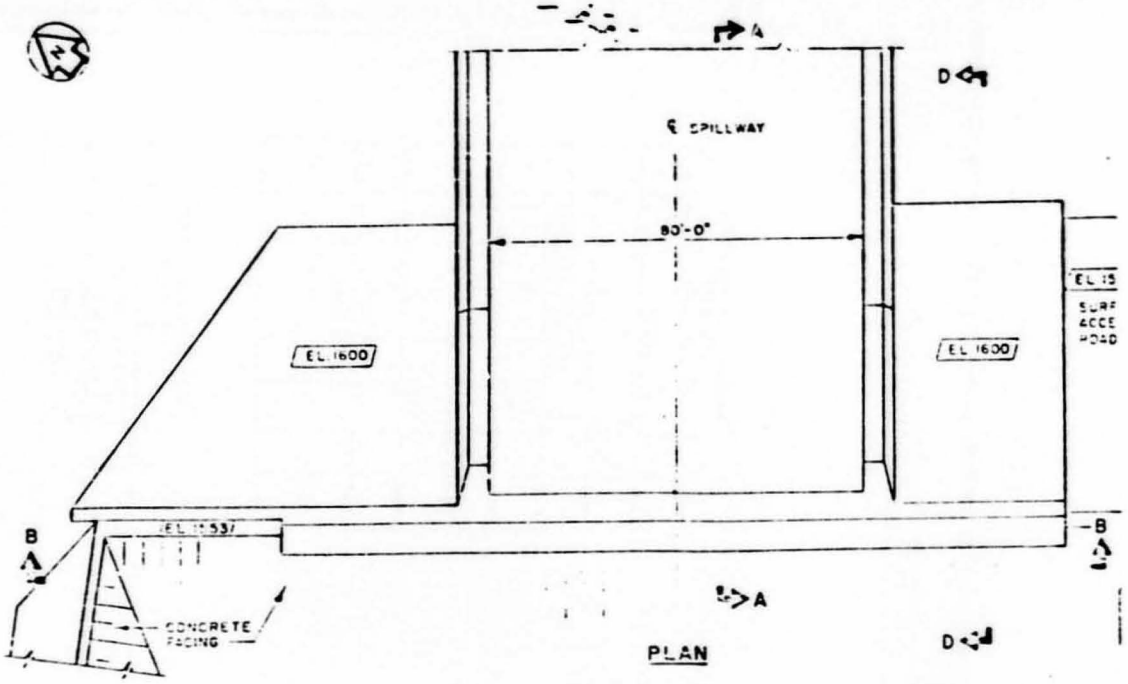

PLAN
SECTION A-A
SECTION B-B
SECTION C-C
SECTION D-D
SPILLWAY
ORIGINAL GROUND SURFACE
TAILRACE TUNNEL
CONC FACING ANCHORED TO ROCK
TOP OF ROCK
ROCK BOLTS (TYP.)
DIVERSION TUNNEL NO 2
DIVERSION TUNNEL NO 1
ACCESS ROAD
SLOPE
BRIDGE
FLIP BUCKET TO BE CONSTRUCTED AFTER DIVERSION
ELEVATION IN FEET
SCALE 0 40 80 FEET (1 INCH = 40 FEET)
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
WATANA
DOWNSTREAM PORTALS
PLAN & SECTIONS
EXHIBIT F
PLATE F20

[redacted]

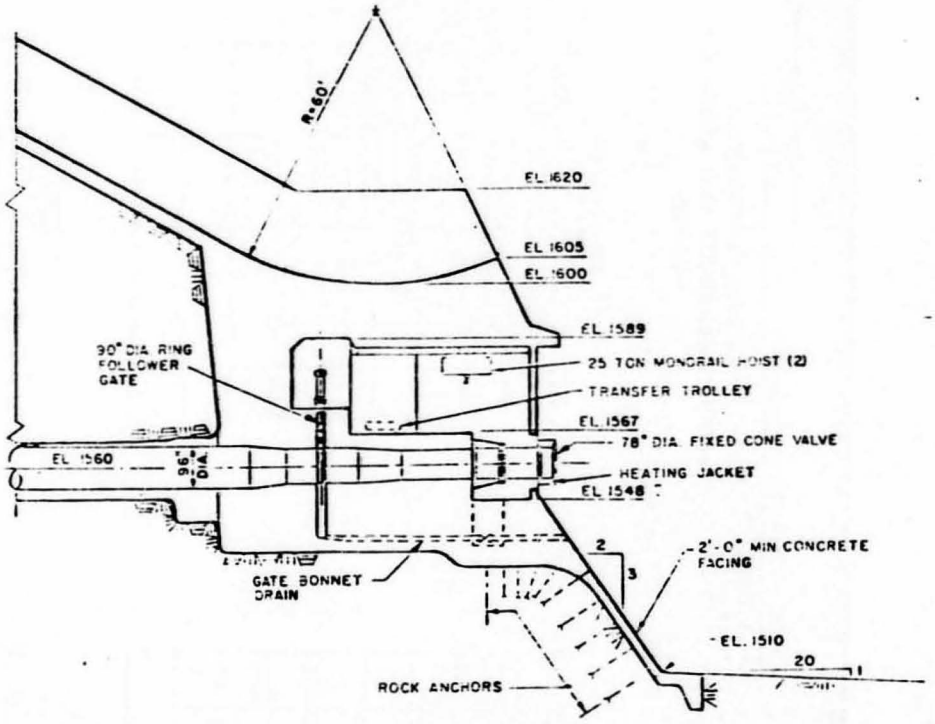

0+00
5+00
C
26'
26'
26'
26'
26'
STEEL LINING
FIXED CONE VALVE (TYP.)
PLAN
SCALE 8


1760
1720
1680
1640
1600
1560
1520
1480
1440
1400
ELEVATION IN FEET
℄ SPILLWAY
ORIGINAL GROUND SURFACE
℄ TAILRACE TUNNEL
CONC FACING ANCHORED TO ROCK
TOP OF ROCK
ROCK BOLTS (TYP)
10
EL 1405

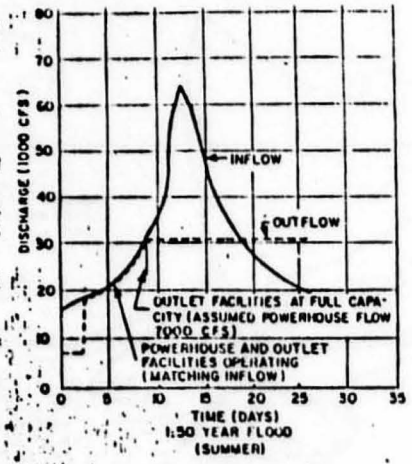
SECTION B-B

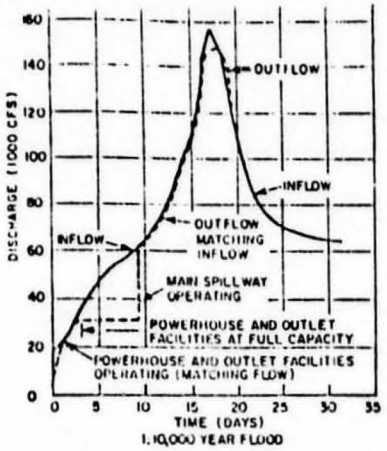


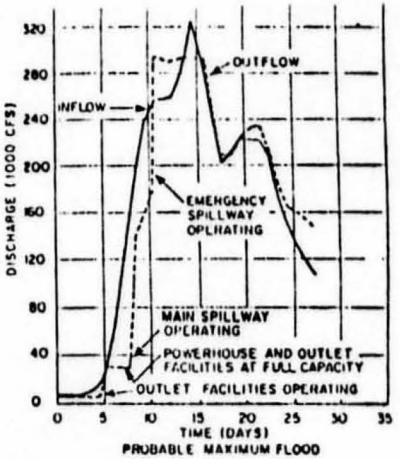

PLAN

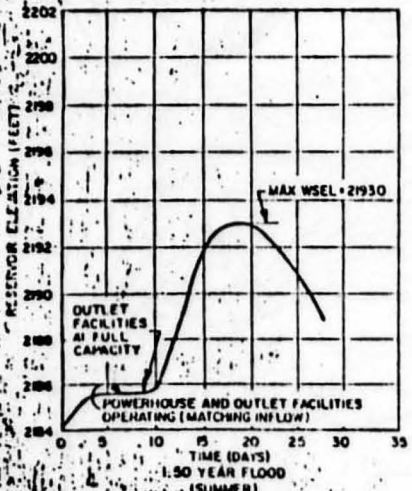


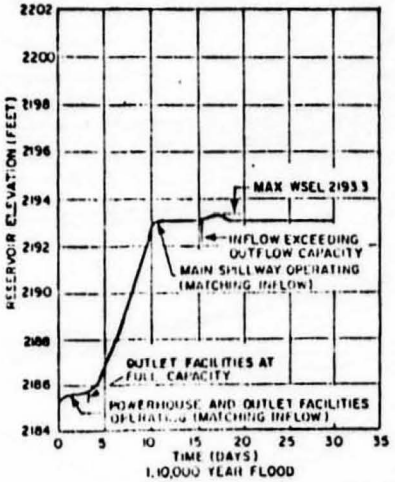

SECTION A-A (TYPICAL)

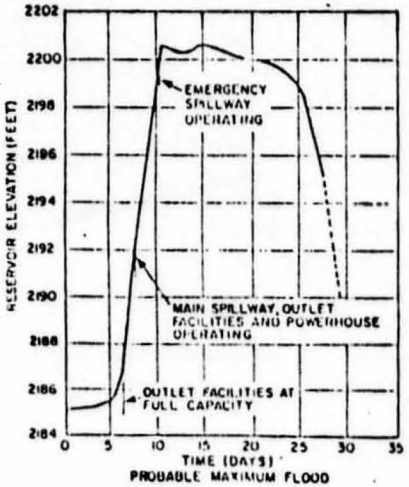


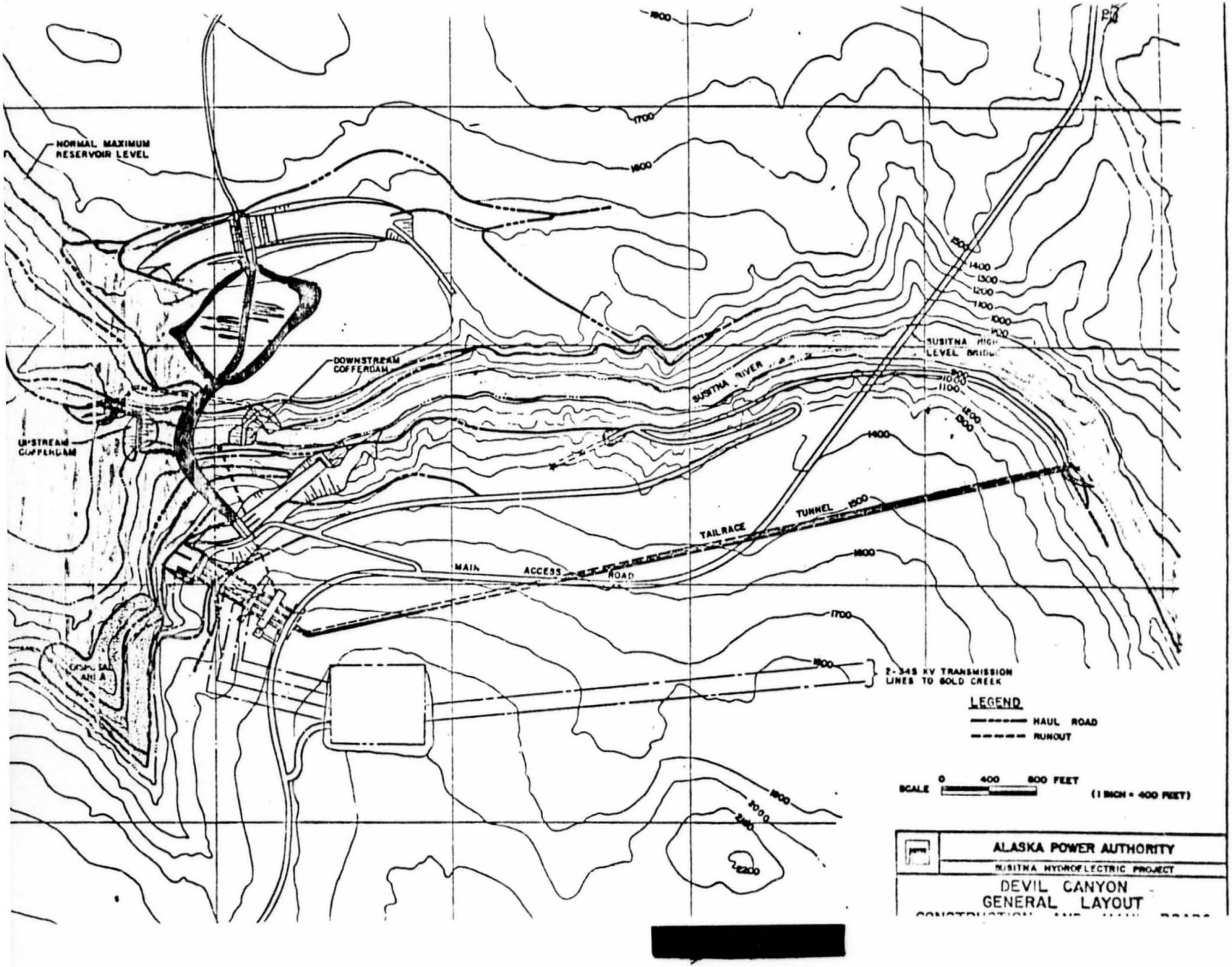



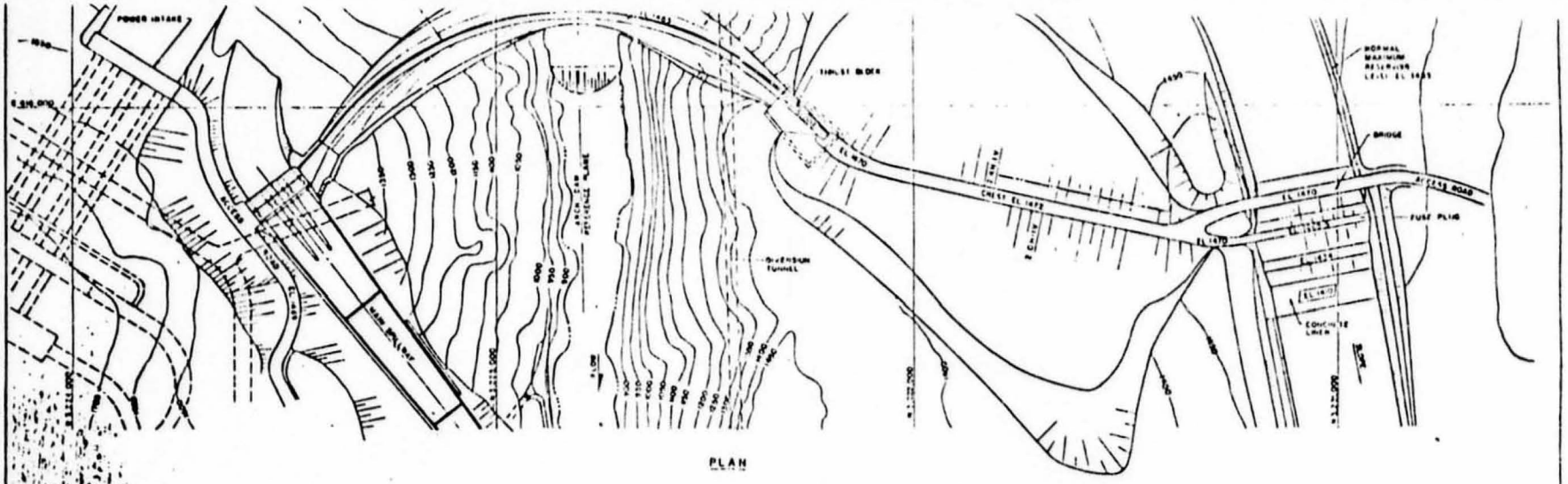



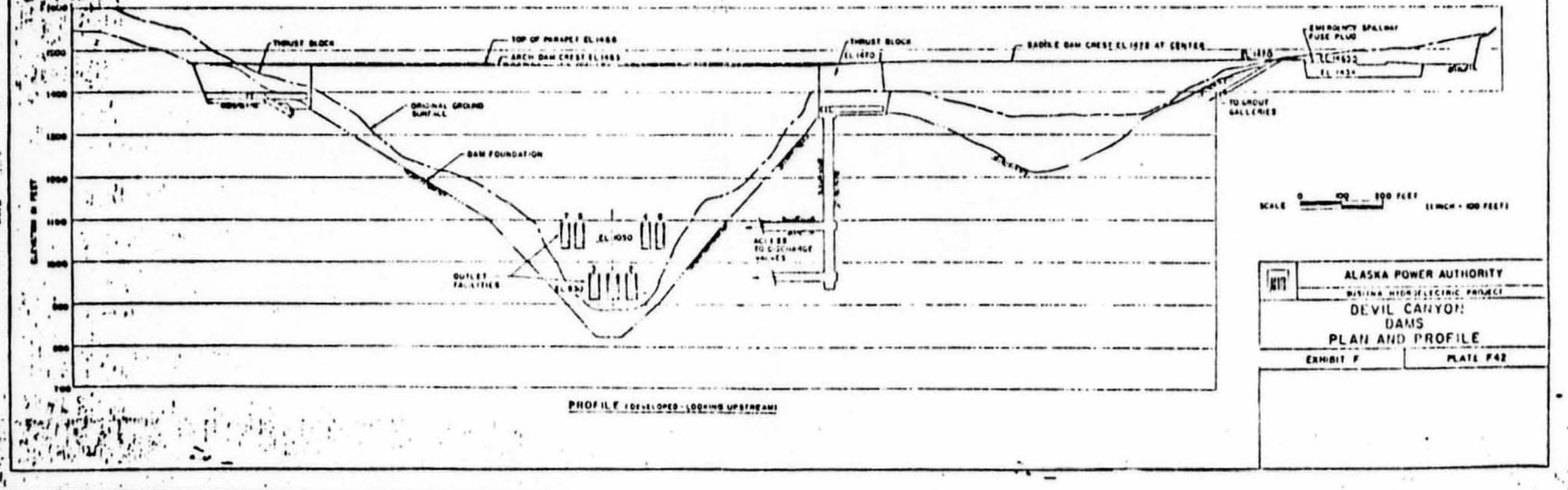




**WATANA**
**FLOOD DISCHARGES AND RESERVOIR SURFACE ELEVATIONS**

FIGURE E-8134


NORMAL MAXIMUM RESERVOIR LEVEL
DOWNSTREAM COFFERDAM
UPSTREAM COFFERDAM
SUSITNA RIVER
TUNNEL
TAILRACE
MAIN ACCESS ROAD
2-345 KV TRANSMISSION LINES TO GOLD CREEK
LEGEND
HAUL ROAD
RUNOUT
SCALE 0 400 800 FEET
(1 INCH = 400 FEET)
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
DEVIL CANYON
GENERAL LAYOUT



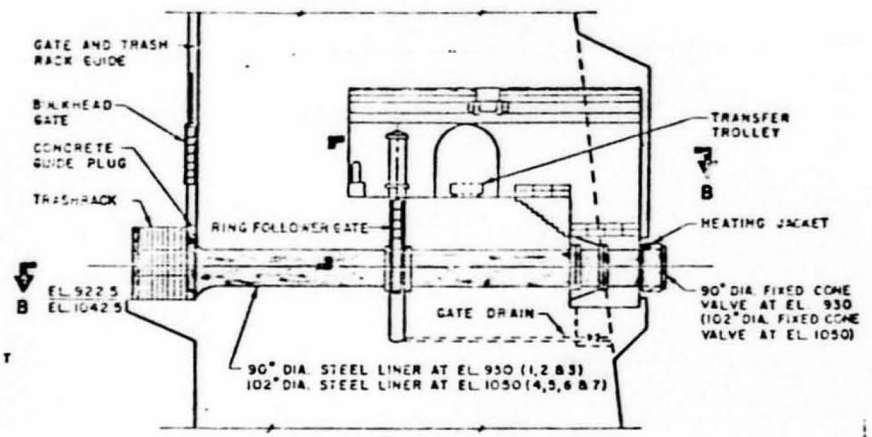

PROFILE (DEVELOPED - LOOKING UPSTREAM)

ALASKA POWER AUTHORITY
MATANUSKA HIGH VOLTAGE ELECTRIC PROJECT

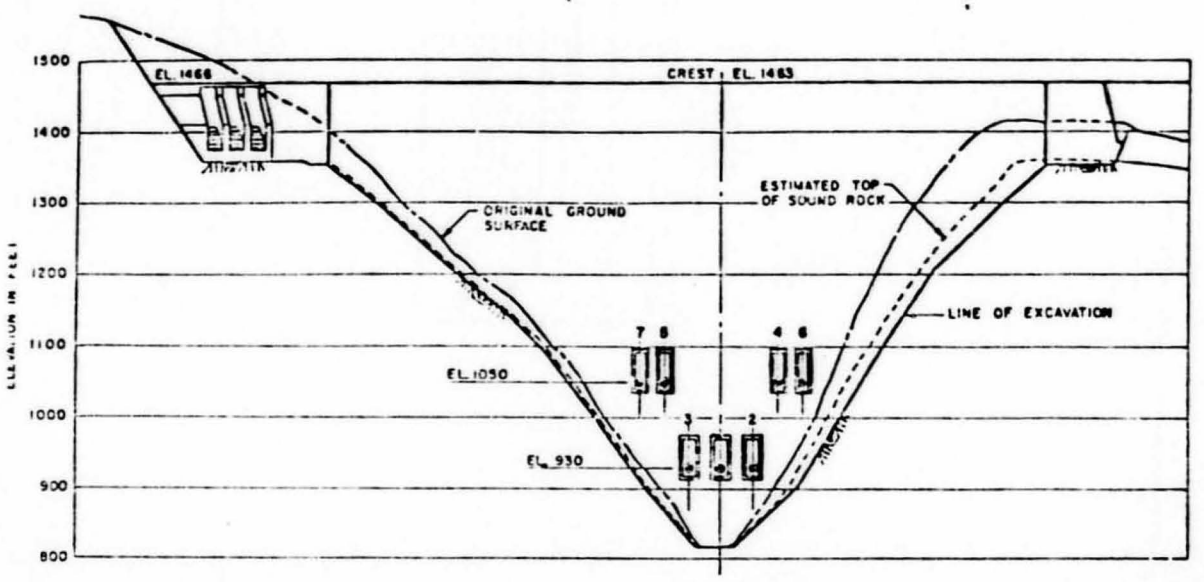
DEVIL CANYON
DAMS
PLAN AND PROFILE

EXHIBIT F | PLATE F42

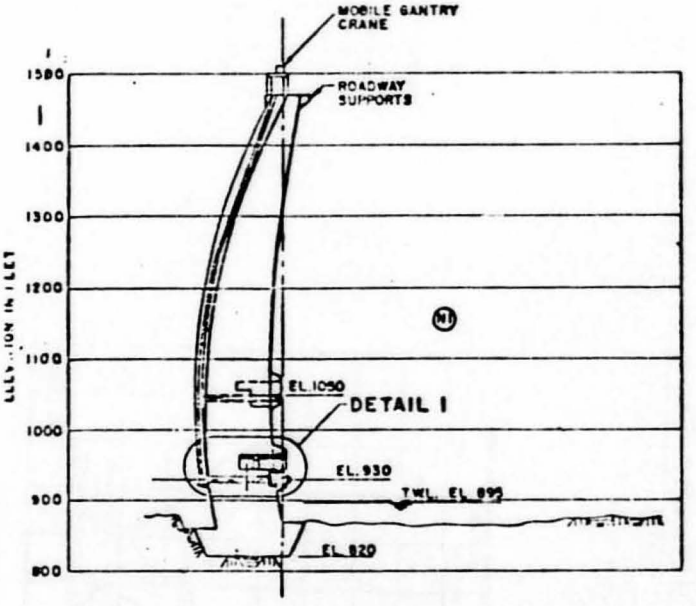
[redacted]



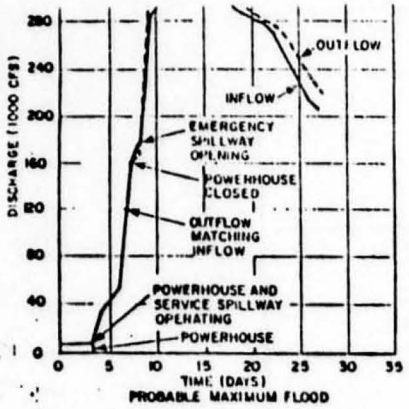

DETAIL I
SCALE 8

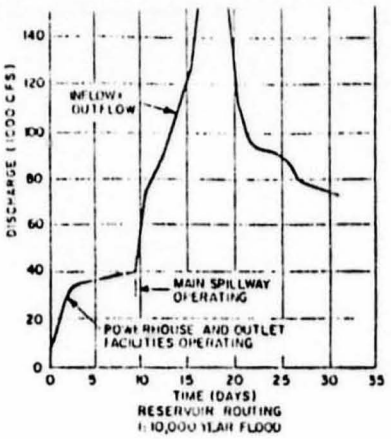


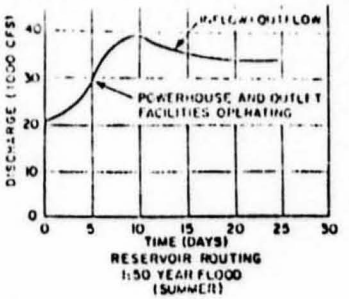

DAM PROFILE (PROJECTION-LOOKING UPSTREAM)
SCALE A

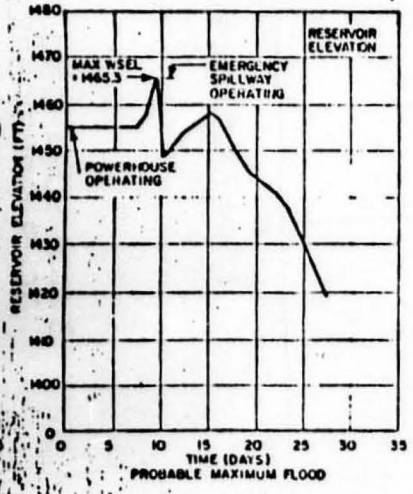


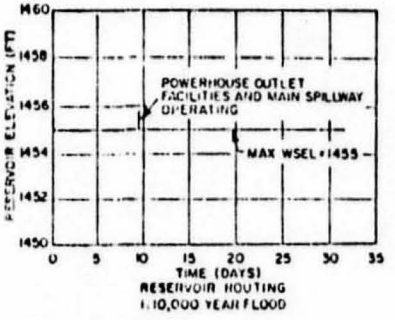

SECTION A-A (TYPICAL)
SCALE A

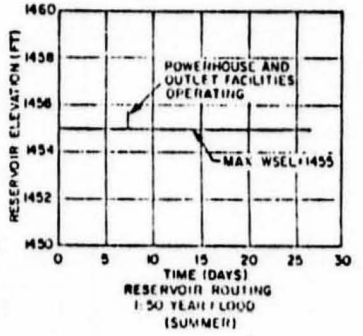


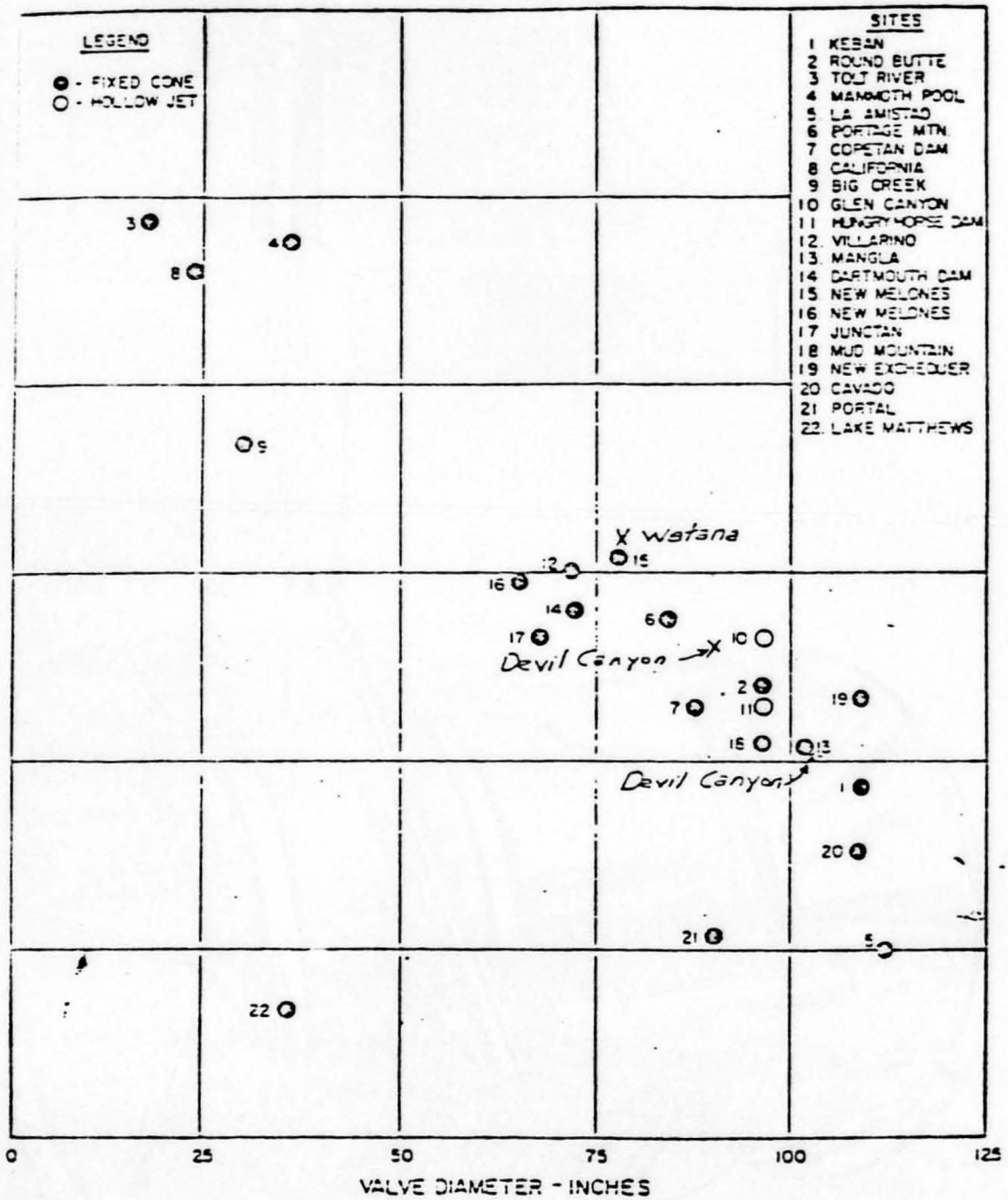




DEVIL CANYON
FLOOD DISCHARGES AND RESERVOIR
SURFACE ELEVATIONS

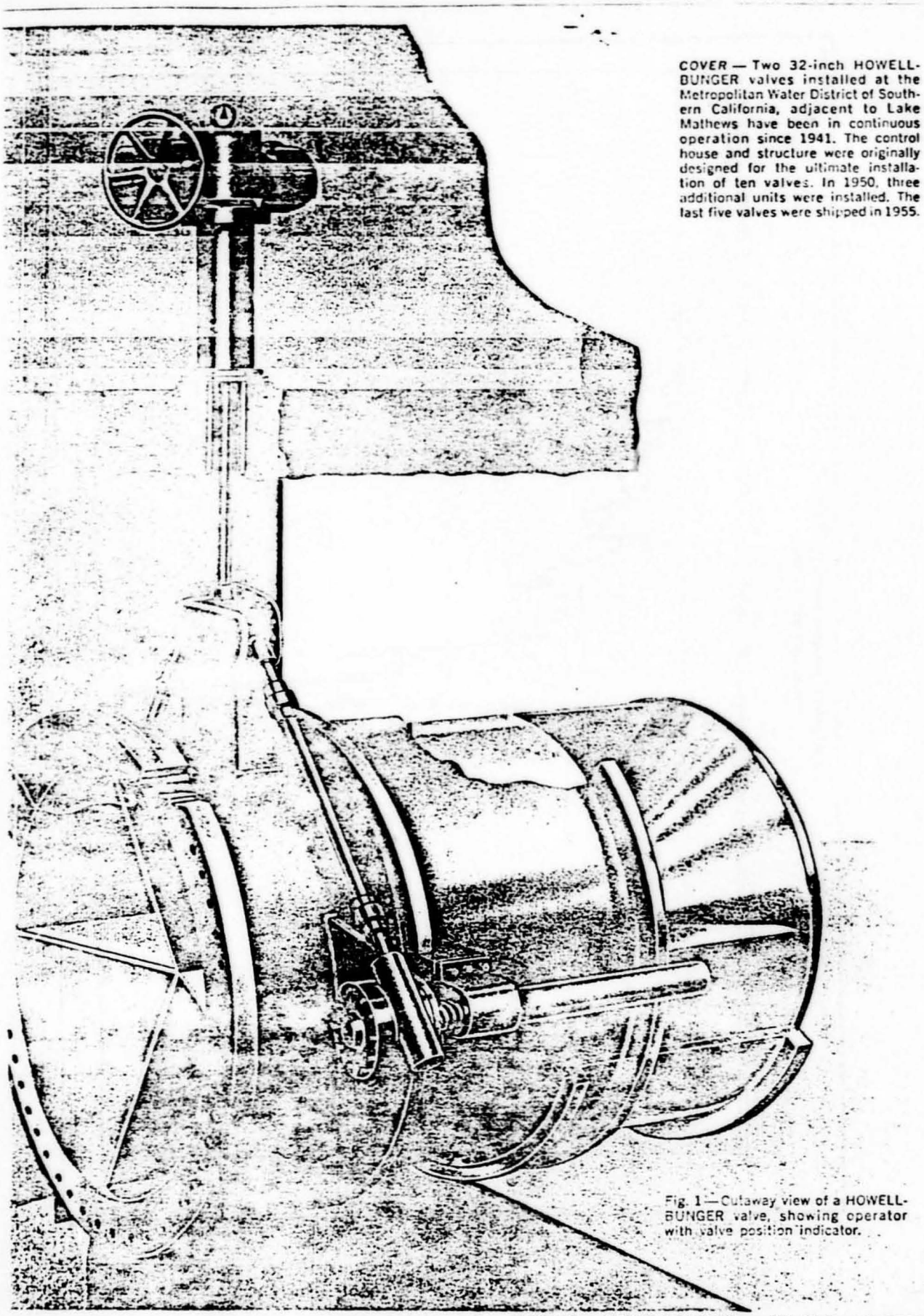
FIGURE E-1.1.00

Figure B.34.1



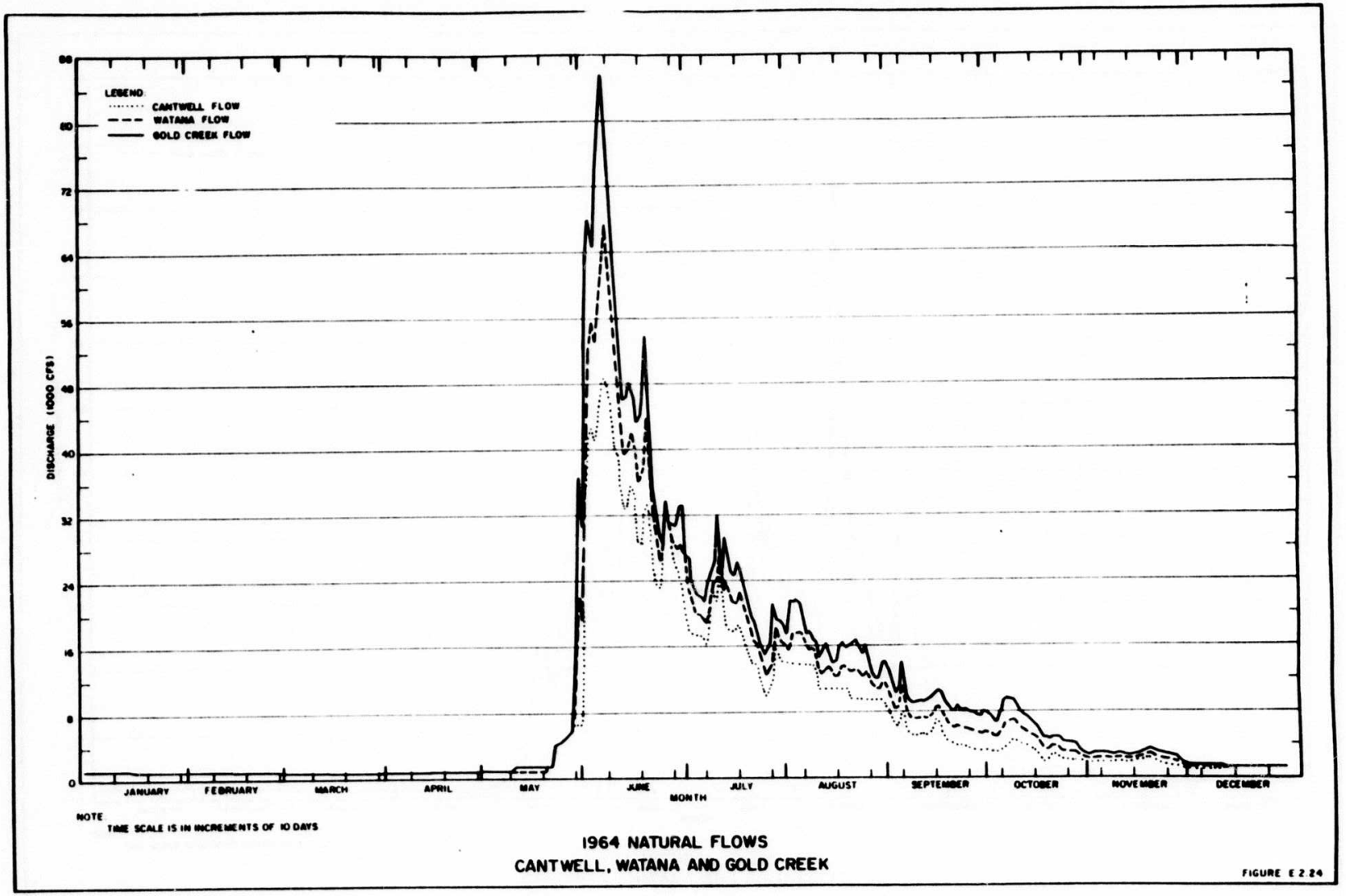

FREE DISCHARGE VALVE
EXPERIENCE PLOT

FIGURE I



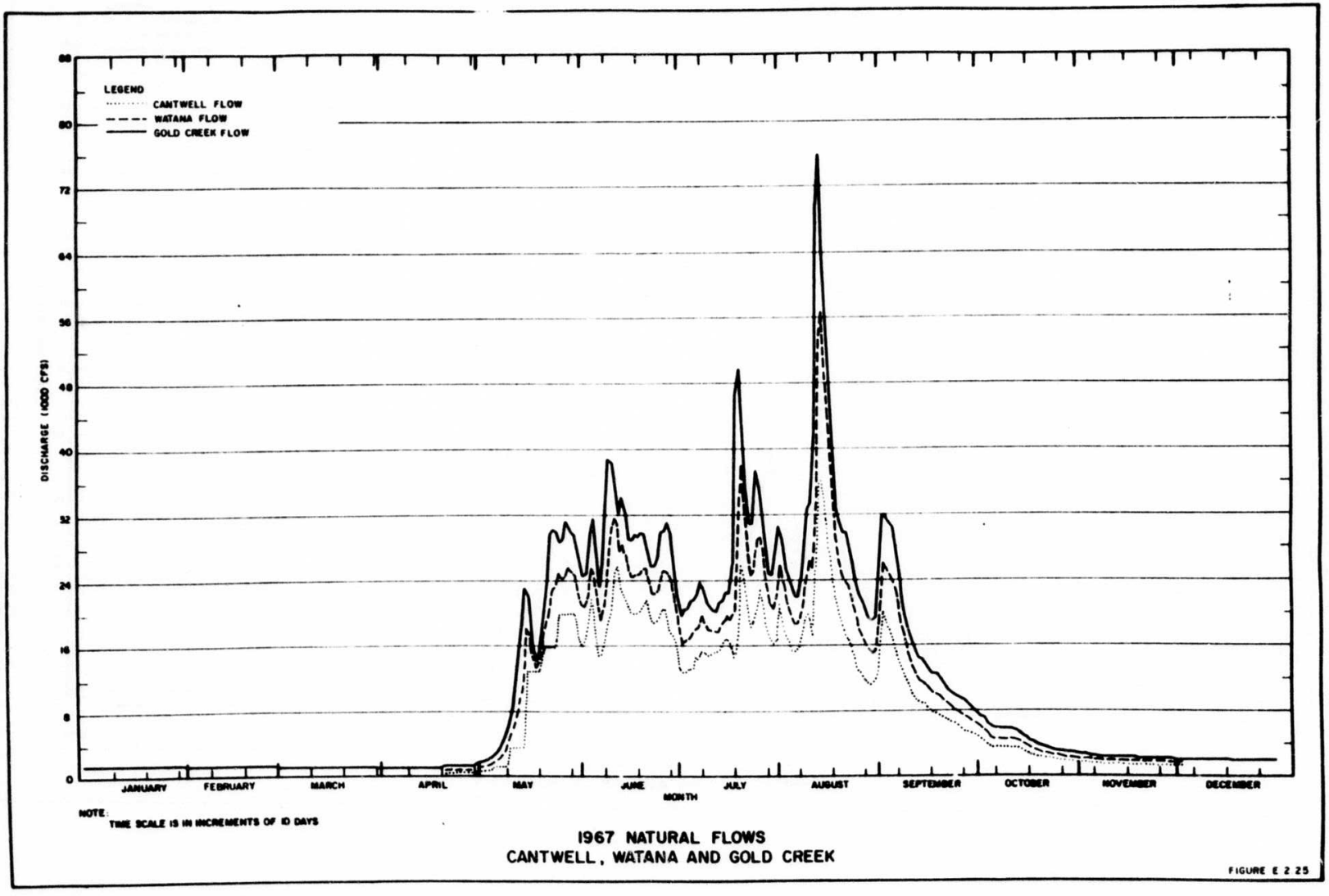
COVER — Two 32-inch HOWELL-BUNGER valves installed at the Metropolitan Water District of Southern California, adjacent to Lake Mathews have been in continuous operation since 1941. The control house and structure were originally designed for the ultimate installation of ten valves. In 1950, three additional units were installed. The last five valves were shipped in 1955.

Fig. 1—Cutaway view of a HOWELL-BUNGER valve, showing operator with valve position indicator.



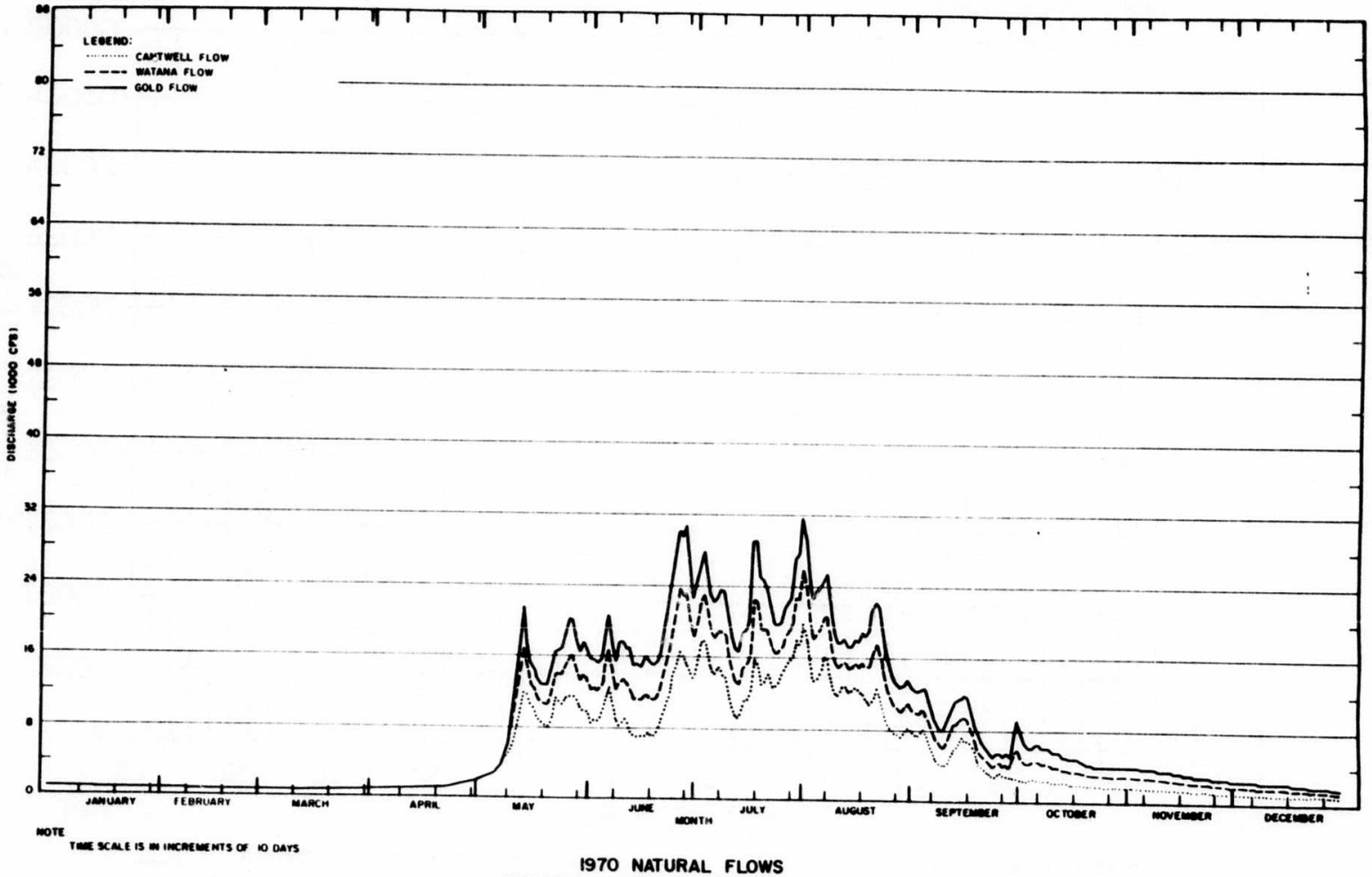

1964 NATURAL FLOWS
CANTWELL, WATANA AND GOLD CREEK

FIGURE E 2.24




1967 NATURAL FLOWS
CANTWELL, WATANA AND GOLD CREEK

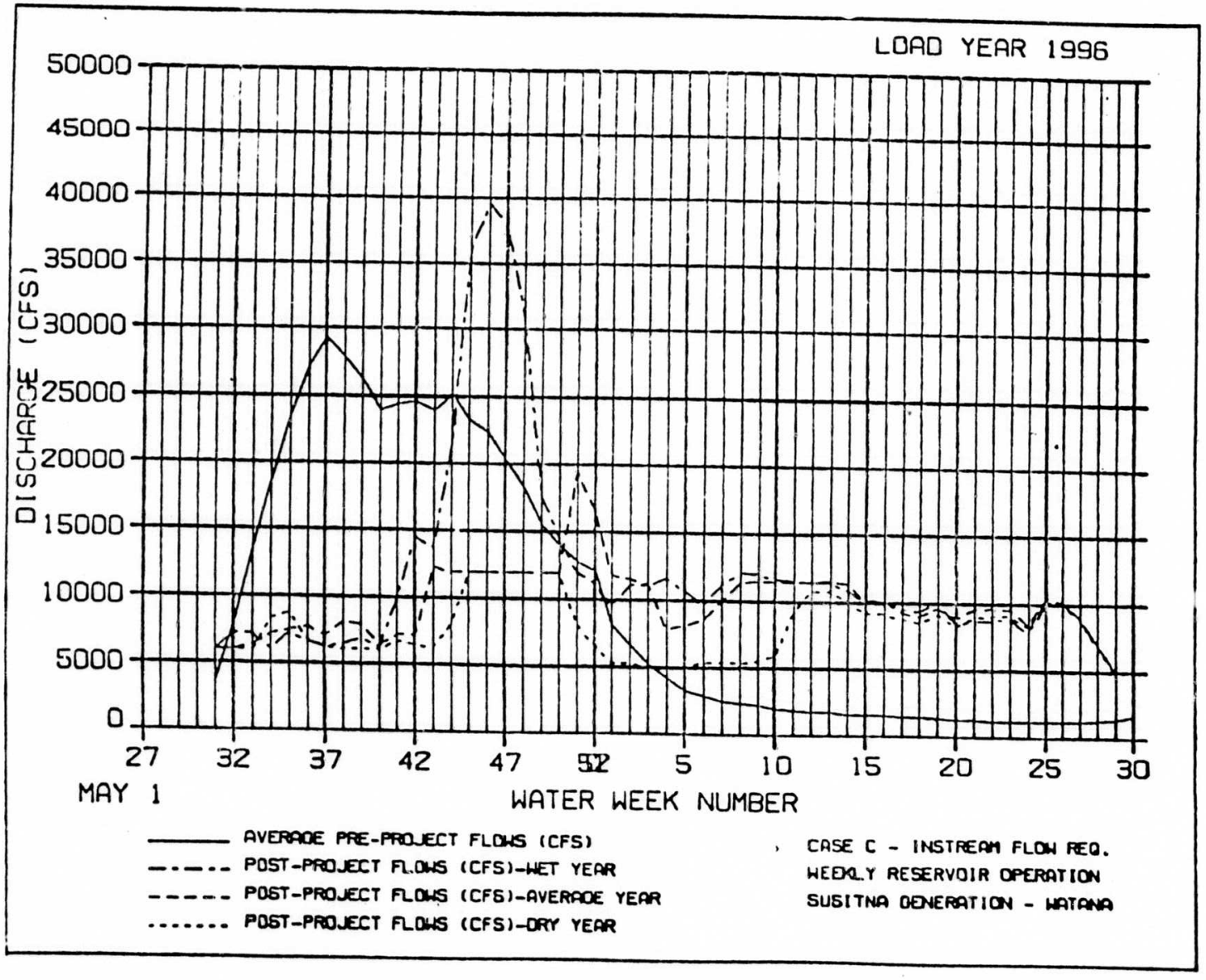
FIGURE E 2 25




NOTE
TIME SCALE IS IN INCREMENTS OF 10 DAYS

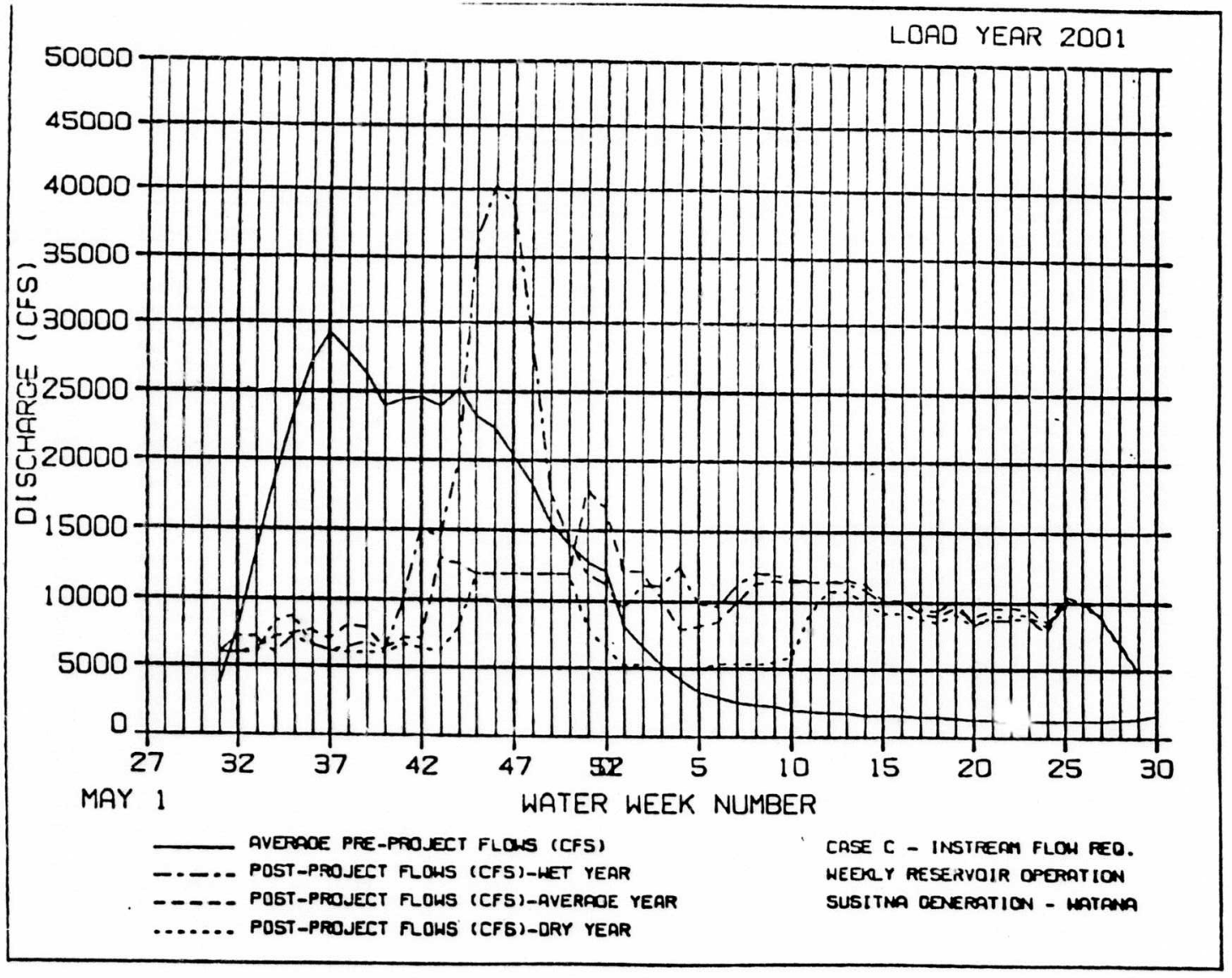
1970 NATURAL FLOWS
CANTWELL, WATANA AND GOLD CREEK

FIGURE E 2 26




WEEKLY PRE--PROJECT AND WITH--PROJECT FLOWS AT GOLD CREEK - LOAD YEAR 1996

EXHIBIT 1



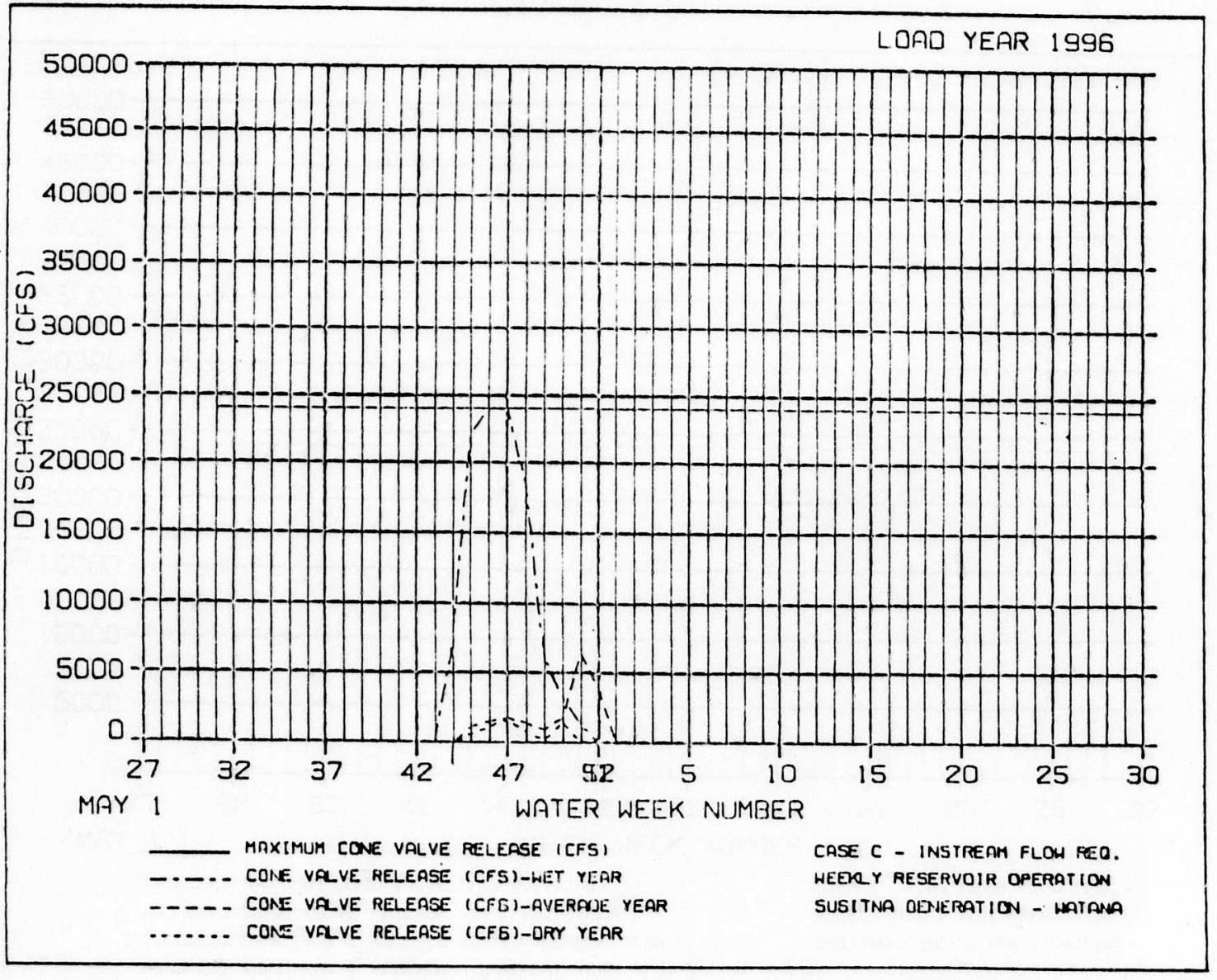

WEEKLY PRE–PROJECT AND WITH--PROJECT FLOWS AT GOLD CREEK - LOAD YEAR 2001

EXHIBIT 2

Table 1

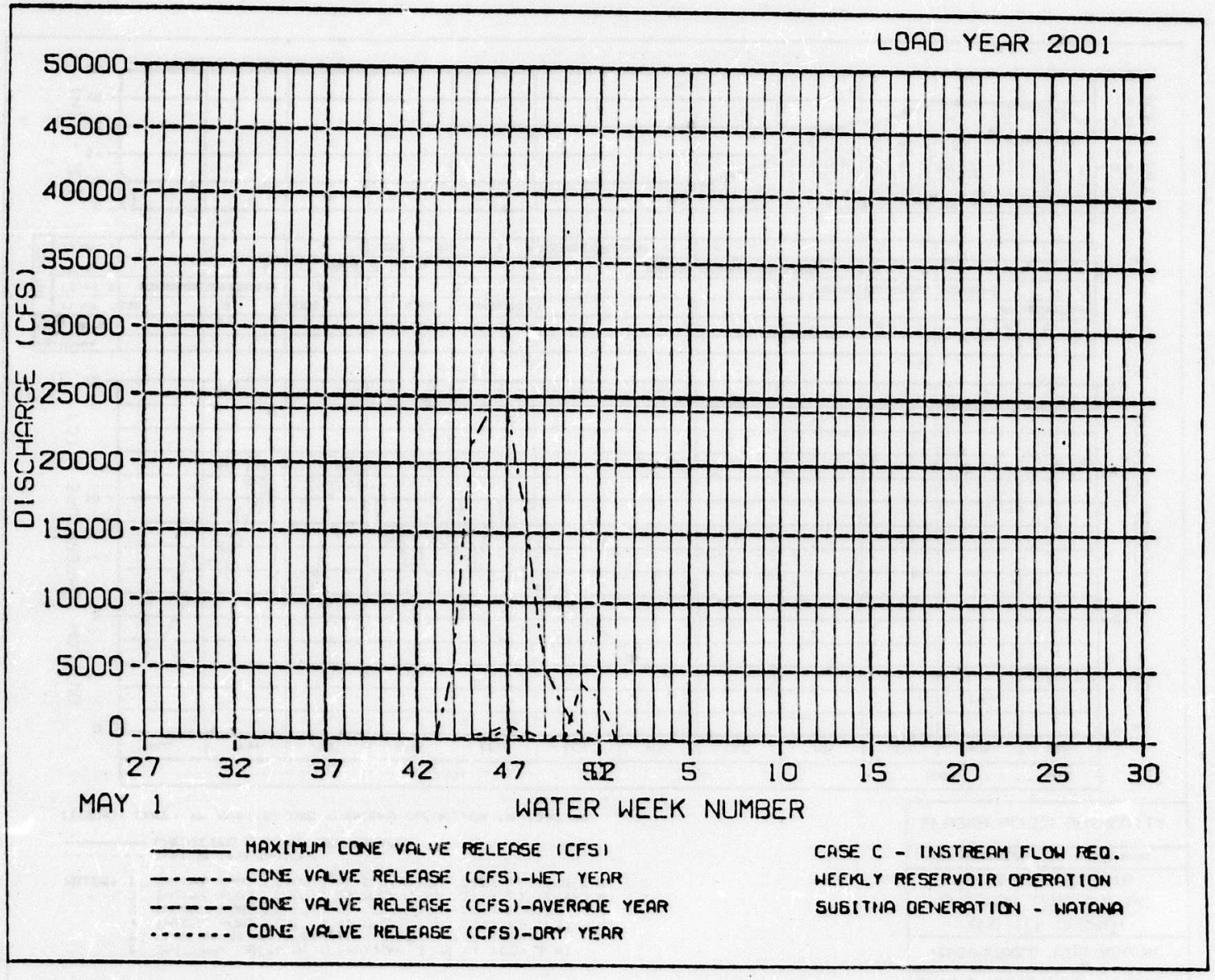
WATANA FIXED CONE VALVE OPERATION

| 1996 Simulation | | | | | 2001 Simulation | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Simulated Water Year | Week of First Release | Week of Maximum Release | Maximum Release (cfs) | Powerhouse Flow (cfs) | Simulated Water Year | Week of First Release | Week of Maximum Release | Maximum Release (cfs) | Powerhouse Flow (cfs) |
| 1950 | Oct 1-7 | Sept 3-9 | 1493 | 9033 | 1950 | Aug 20-26 | Aug 27-Sept 2 | 652 | 9253 |
| 1951 | Aug 6-12 | Sept 3-9 | 9129 | 8947 | 1951 | Aug 6-12 | Sept 3-9 | 8270 | 9805 |
| 1952 | Aug 13-19 | Sept 3-9 | 6956 | 8925 | 1952 | Aug 20-26 | Sept 3-9 | 6100 | 9781 |
| 1953 | Aug 6-12 | Sept 3-9 | 6872 | 8925 | 1953 | Aug 13-19 | Sept 3-9 | 6016 | 9781 |
| 1954 | Aug 13-19 | Aug 20-26 | 11981 | 8201 | 1954 | Aug 13-19 | Aug 20-26 | 11194 | 8988 |
| 1955 | Aug 6-12 | Aug 27-Sept 2 | 22931 | 8387 | 1955 | Aug 20-26 | Aug 27-Sept 2 | 22126 | 9192 |
| 1956 | July 29-Aug 5 | Aug 6-12 | 15982 | 8212 | 1956 | July 29-Aug 5 | Aug 6-12 | 15195 | 9000 |
| 1957 | Aug 27-Sept 2 | Sept 10-16 | 8430 | 8929 | 1957 | Aug 27-Sept 2 | Sept 10-16 | 7573 | 9786 |
| 1958 | Aug 13-19 | Aug 20-26 | 5750 | 8185 | 1958 | Aug 13-19 | Aug 20-26 | 4965 | 8970 |
| 1959 | Aug 6-12 | Aug 27-Sept 2 | 24000 | 8395 | 1959 | Aug 20-26 | Aug 27-Sept 2 | 24000 | 9201 |
| 1960 | Aug 13-19 | Sept 10-16 | 15389 | 8949 | 1960 | Sept 3-9 | Sept 10-16 | 14530 | 9808 |
| 1961 | Oct 1-7 | Aug 20-26 | 9524 | 8195 | 1961 | Aug 13-19 | Aug 20-26 | 8738 | 8981 |
| 1962 | July 29-Aug 5 | July 29-Aug 5 | 13600 | 8101 | 1962 | July 29-Aug 5 | Aug 27-Sept 2 | 10542 | 9160 |
| 1963 | July 29-Aug 5 | Aug 6-12 | 12939 | 8204 | 1963 | July 29-Aug 5 | Aug 6-12 | 12152 | 8991 |
| 1964 | Aug 6-12 | Aug 27-Sept 2 | 3100 | 8336 | 1964 | Aug 13-19 | Sept 10-16 | 740 | 9788 |
| 1965 | Aug 6-12 | Sept 24-30 | 10910 | 10149 | 1965 | Aug 20-26 | Sept 24-30 | 9936 | 11123 |
| 1966 | Oct 1-7 | Sept 3-9 | 7043 | 8911 | 1966 | Oct 1-7 | Aug 27-Sept 2 | 6242 | 9147 |
| 1967 | Aug 6-12 | Aug 13-19 | 24000 | 8252 | 1967 | Aug 6-12 | Aug 13-19 | 24000 | 9044 |
| 1968 | Aug 6-12 | Aug 27-Sept 2 | 2957 | 8336 | 1968 | Aug 13-19 | Aug 27-Sept 2 | 711 | 9152 |
| 1969 | Aug 6-12 | Aug 20-26 | 2401 | 8645 | 1969 | Aug 6-12 | Aug 20-26 | 1409 | 9475 |
| 1970 | Aug 13-19 | Aug 10-16 | 1189 | 9305 | 1970 | Aug 27-Sept 2 | Sept 10-16 | 296 | 10198 |
| 1971 | Aug 13-19 | Aug 13-19 | 21425 | 8234 | 1971 | Aug 13-19 | Aug 13-19 | 19839 | 9023 |
| 1972 | Aug 6-12 | Aug 20-26 | 9129 | 8194 | 1972 | Aug 20-26 | Aug 20-26 | 7564 | 8979 |
| 1973 | Aug 6-12 | Sept 10-16 | 1557 | 9020 | 1973 | Aug 13-19 | Sept 10-16 | 692 | 9885 |
| 1974 | Aug 6-12 | Aug 20-26 | 1612 | 8376 | 1974 | Aug 13-19 | Aug 20-26 | 809 | 9179 |
| 1975 | Aug 6-12 | Sept 10-16 | 7538 | 8927 | 1975 | Aug 13-19 | Sept 10-16 | 6681 | 9784 |
| 1976 | Aug 13-19 | Sept 10-16 | 1978 | 9015 | 1976 | Aug 20-26 | Sept 10-16 | 1114 | 9880 |
| 1977 | Aug 6-12 | Aug 20-26 | 6293 | 8191 | 1977 | Aug 27-Sept 2 | Sept 17-23 | 2000 | 9769 |
| 1978 | Aug 6-12 | Aug 27-Sept 2 | 1780 | 8521 | 1978 | Aug 20-26 | Aug 27-Sept 2 | 962 | 9338 |
| 1979 | Aug 13-19 | Aug 13-19 | 6944 | 8192 | 1979 | Aug 13-19 | Aug 20-26 | 5372 | 8971 |
| 1980 | July 29-Aug 5 | Aug 6-12 | 11310 | 8200 | 1980 | Aug 6-12 | Aug 13-19 | 9457 | 8983 |
| 1981 | July 29-Aug 5 | Aug 13-19 | 24000 | 8242 | 1981 | July 29-Aug 5 | Aug 13-19 | 24000 | 9032 |
| 1982 | Aug 6-12 | Sept 17-23 | 6426 | 8939 | 1982 | Aug 6-12 | Sept 17-23 | 4008 | 9795 |
| 1983 | Aug 20-26 | Aug 27 Sept 2 | 14063 | 8365 | 1983 | Aug 20-26 | Aug 27-Sept 2 | 13261 | 9167 |



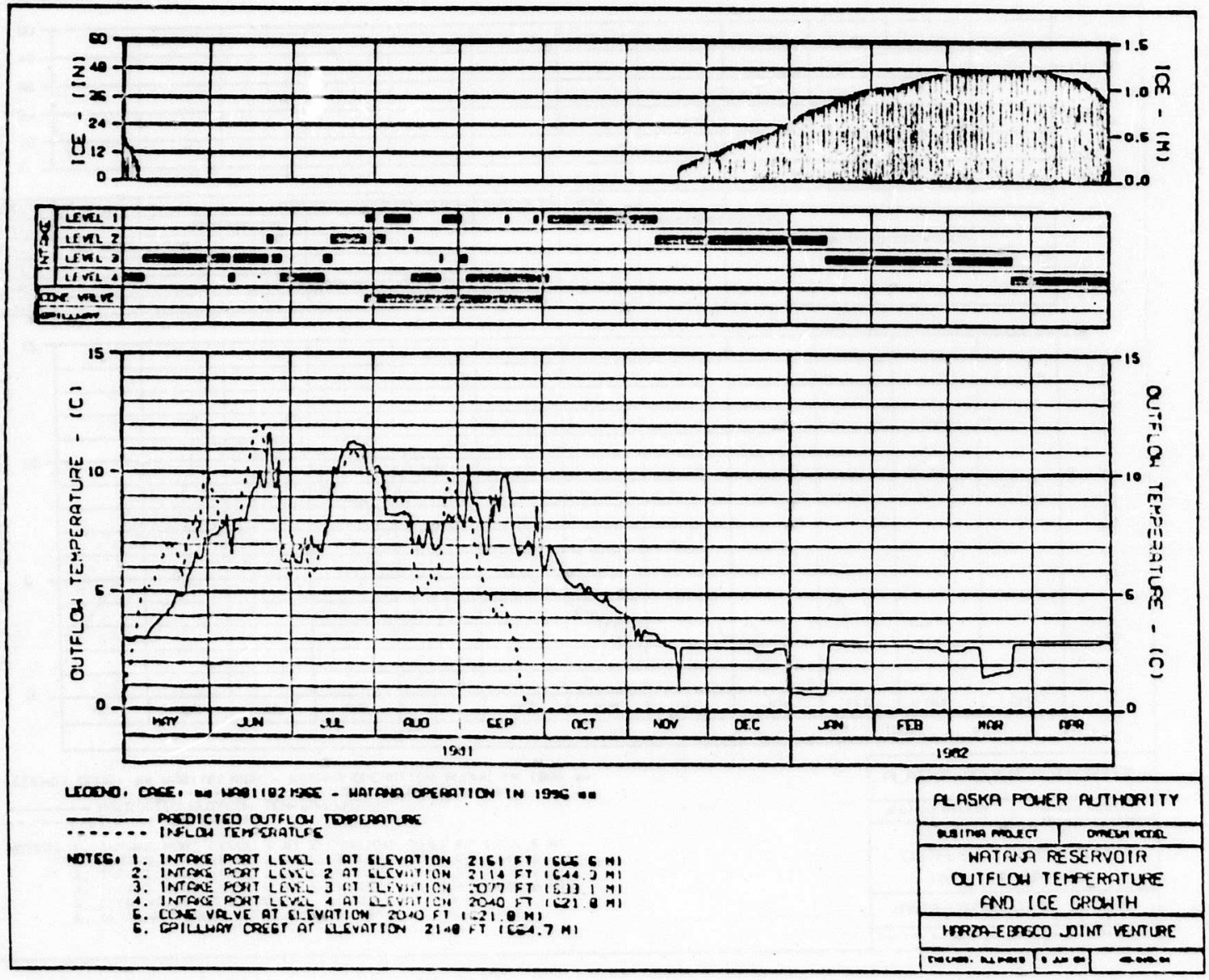

WEEKLY CONE VALVE OPERATION - LOAD YEAR 1996

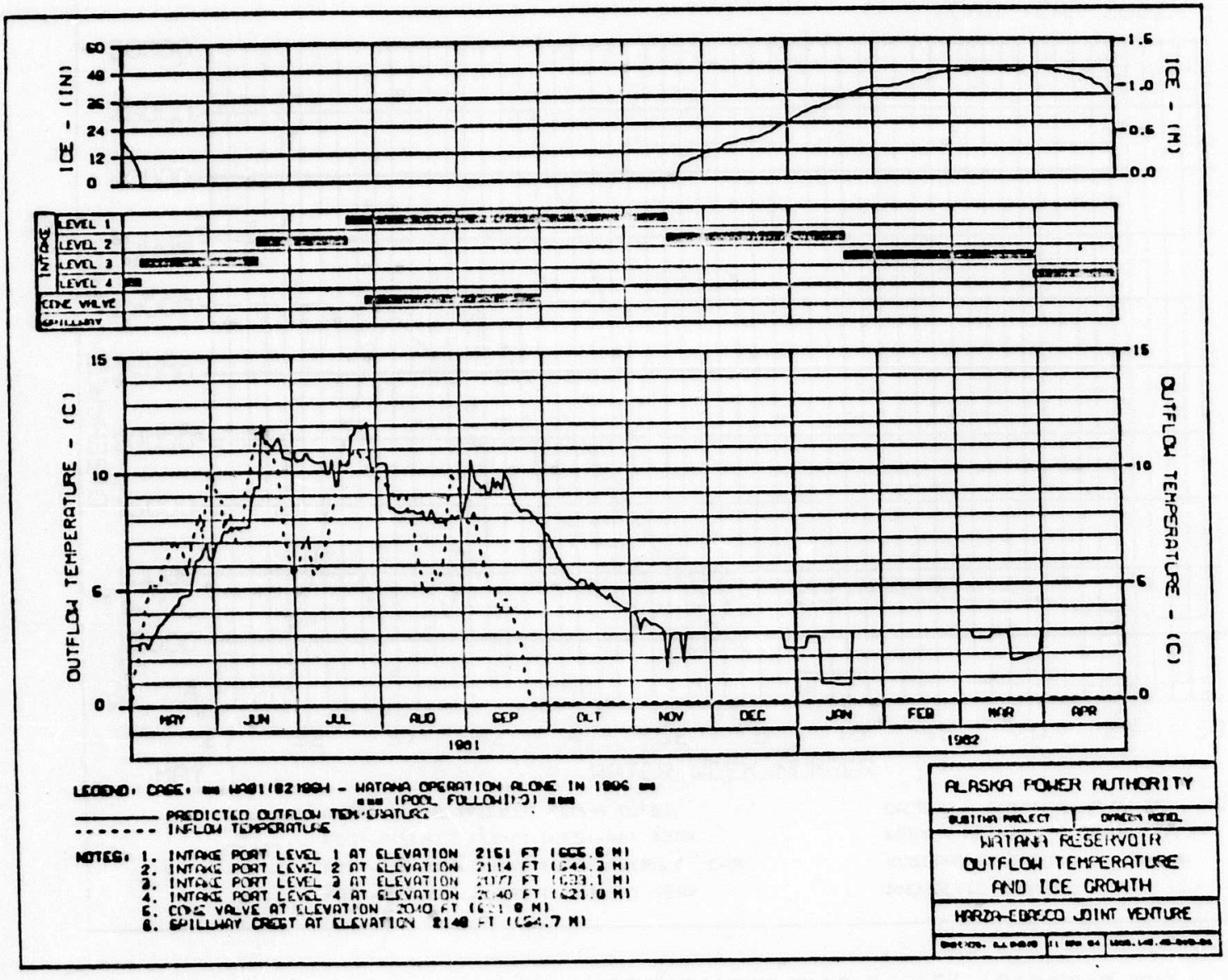
EXHIBIT 15

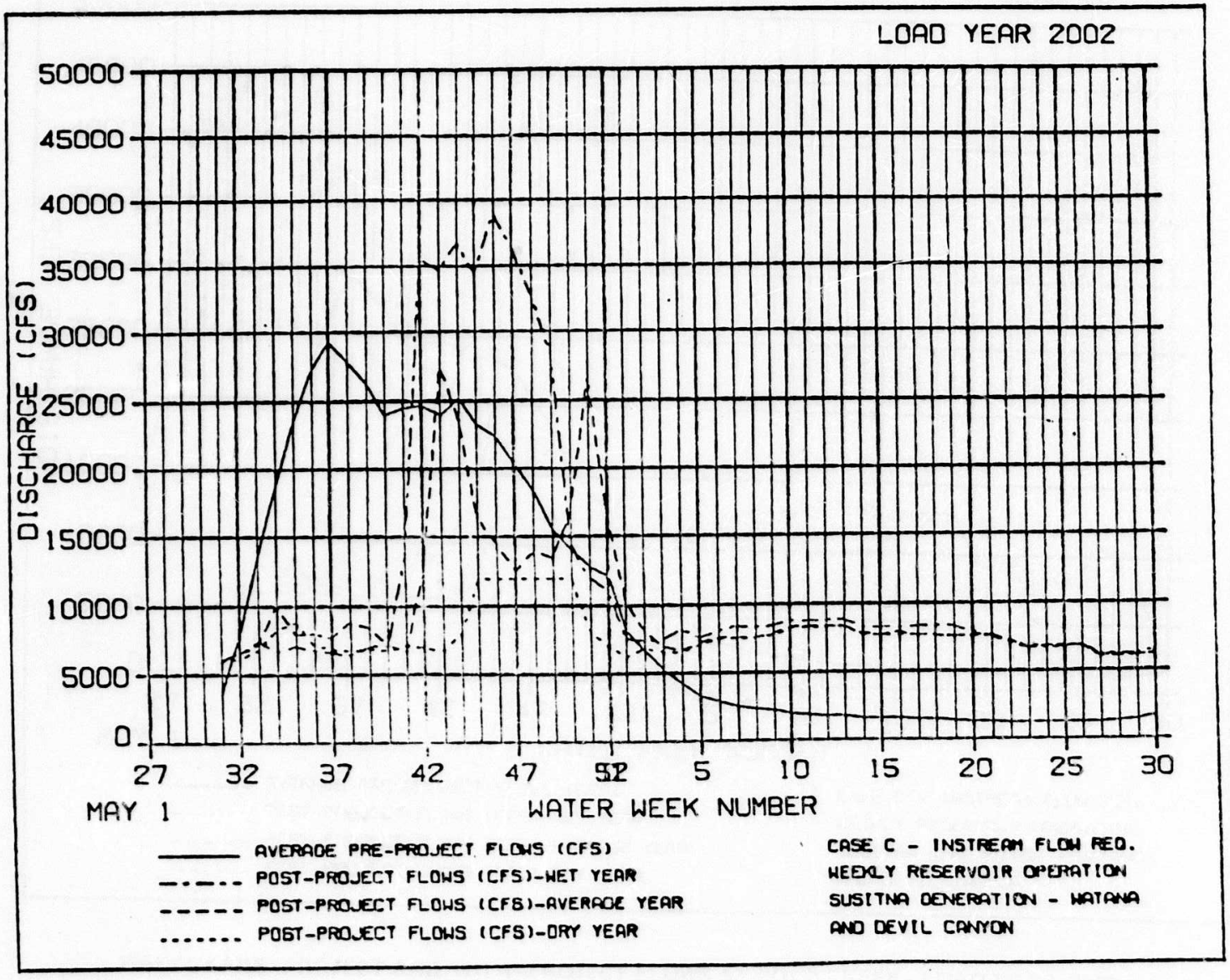



WEEKLY CONE VALVE OPERATION - LOAD YEAR 2001

EXHIBIT 16

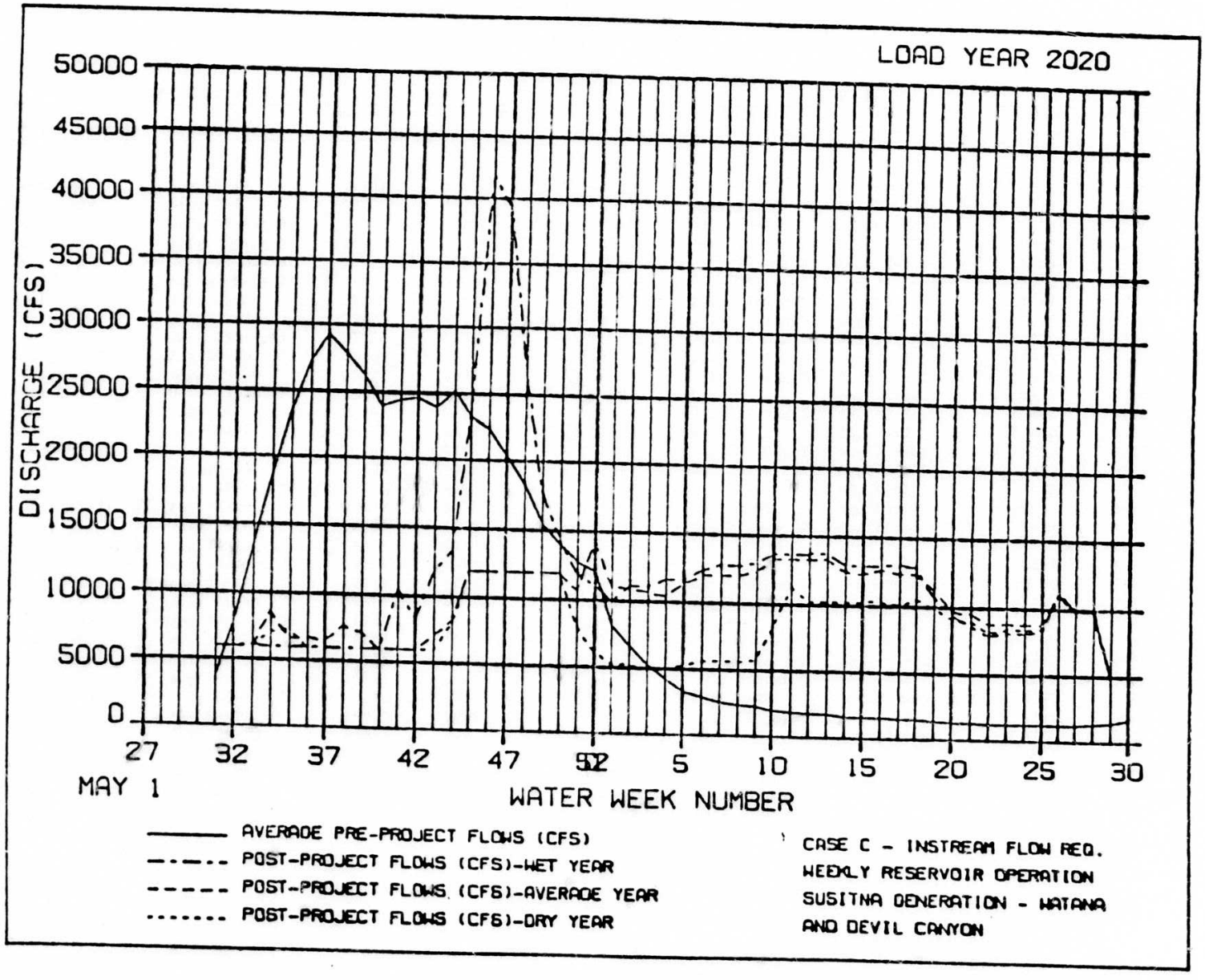

ICE - (IN)
60
48
36
24
12
0
1.5
1.0
0.5
0.0
ICE - (M)
INTAKE
LEVEL 1
LEVEL 2
LEVEL 3
LEVEL 4
CONE VALVE
SPILLWAY
OUTFLOW TEMPERATURE - (C)
15
10
5
0
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
1991
1992
LEGEND: CASE: 88 WA81192MSE - WATANA OPERATION IN 1996 88
PREDICTED OUTFLOW TEMPERATURE
INFLOW TEMPERATURE
NOTES: 1. INTAKE PORT LEVEL 1 AT ELEVATION 2161 FT (665.6 MI)
2. INTAKE PORT LEVEL 2 AT ELEVATION 2114 FT (644.0 MI)
3. INTAKE PORT LEVEL 3 AT ELEVATION 2077 FT (633.1 MI)
4. INTAKE PORT LEVEL 4 AT ELEVATION 2040 FT (621.8 MI)
5. CONE VALVE AT ELEVATION 2040 FT (621.8 MI)
6. SPILLWAY CREST AT ELEVATION 2140 FT (654.7 MI)
ALASKA POWER AUTHORITY
SUSITNA PROJECT
DYNEVR MODEL
WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH
HARZA-EBASCO JOINT VENTURE


ICE - (IN)
60
48
36
24
12
0
1.5
1.0
0.5
0.0
ICE - (M)
INTAKE
LEVEL 1
LEVEL 2
LEVEL 3
LEVEL 4
CONE VALVE
SPILLWAY
OUTFLOW TEMPERATURE - (C)
15
10
5
0
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
1981
1982
LEGEND: CASE: WA81182 1984 - WATANA OPERATION ALONE IN 1996
(POOL FOLLOWING)
PREDICTED OUTFLOW TEMPERATURE
INFLOW TEMPERATURE
NOTES: 1. INTAKE PORT LEVEL 1 AT ELEVATION 2161 FT (655.6 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT LEVEL 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE AT ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)
ALASKA POWER AUTHORITY
SUSITNA PROJECT
WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH
HARZA-EBASCO JOINT VENTURE




WEEKLY PRE-PROJECT AND WITH-PROJECT FLOWS AT GOLD CREEK - LOAD YEAR 2002

EXHIBIT 3



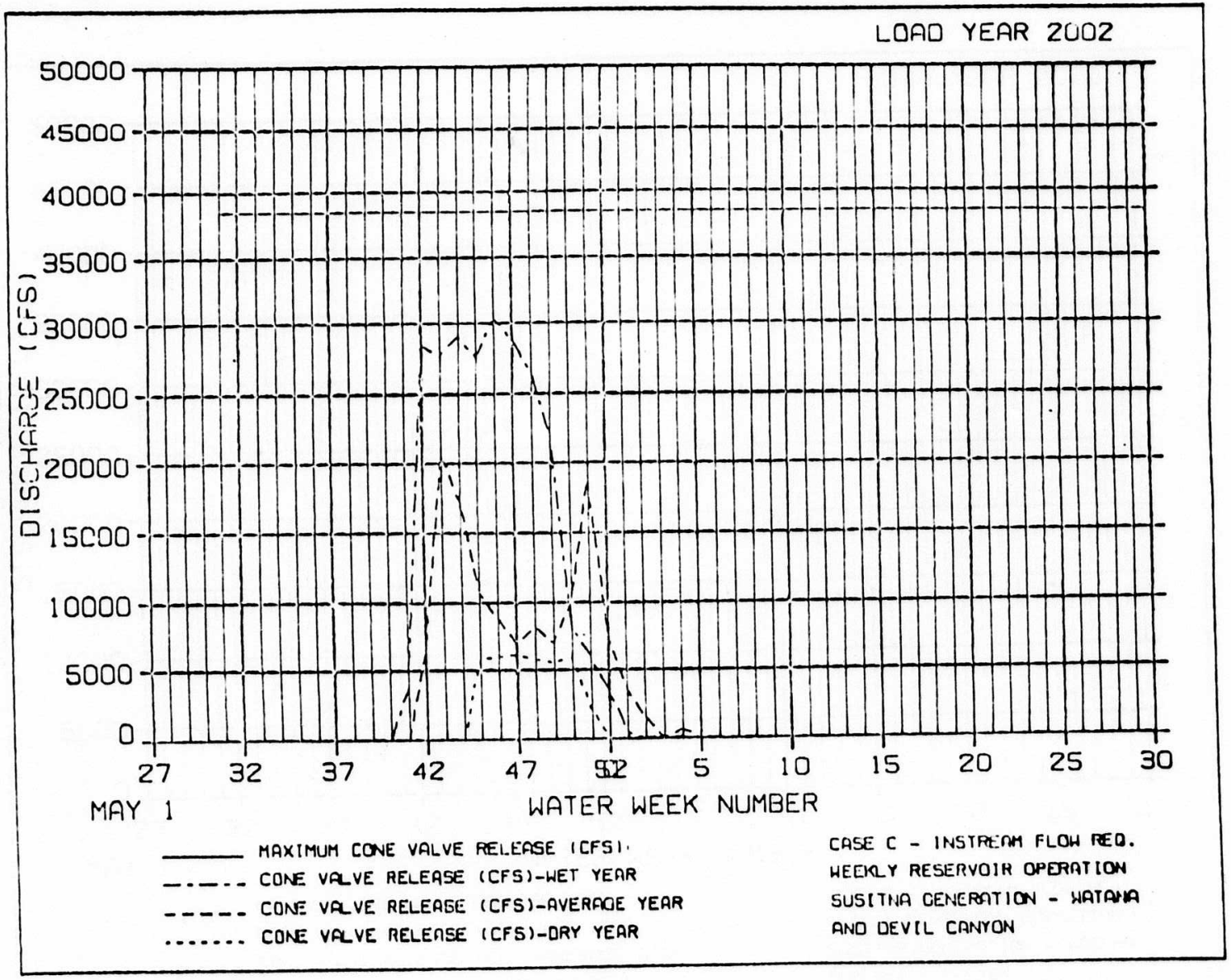

WEEKLY PRE-PROJECT AND WITH-PROJECT FLOWS AT GOLD CREEK - LOAD YEAR 2020

EXHIBIT 4

Table 2

## DEVIL CANYON FIXED CONE VALVE OPERATION

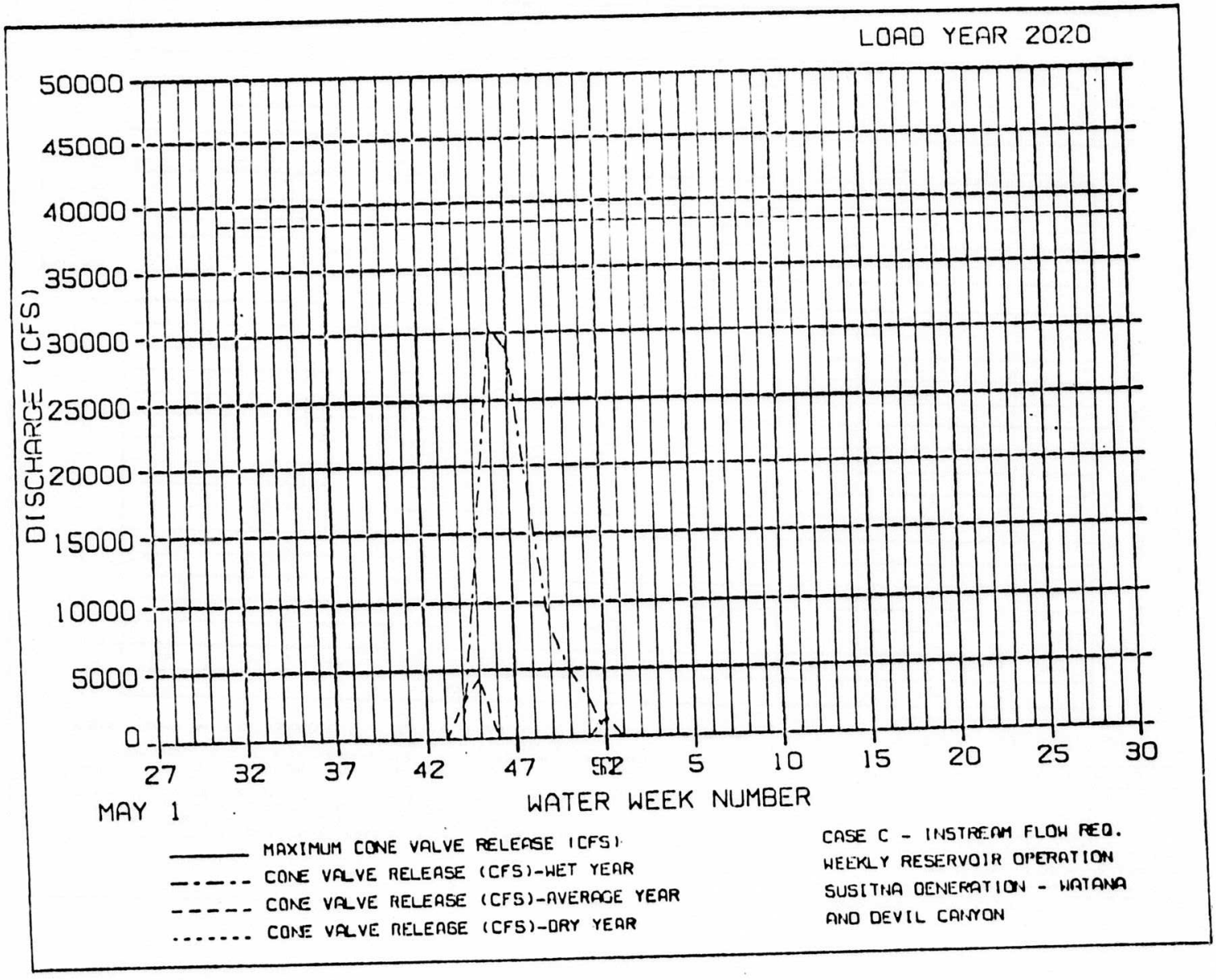
| 2002 Simulation | | | | | 2020 Simulation | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Simulated Water Year | Week of First Release | Week of Maximum Release | Maximum Release (cfs) | Powerhouse Flow (cfs) | Simulated Water Year | Week of First Release | Week of Maximum Release | Maximum Release (cfs) | Powerhouse Flow (cfs) |
| 1950 | Oct 1-7 | Aug 13-19 | 11502 | 5018 | 1950 | Oct 1-7 | Aug 6-12 | 4381 | 6305 |
| 1951 | Aug 6-12 | Sept 3-9 | 22874 | 5476 | 1951 | July 29-Aug 5 | Sept 24-30 | 6757 | 9829 |
| 1952 | Oct 1-7 | July 29-Aug 5 | 27827 | 4972 | 1952 | July 29-Aug 5 | Aug 6-12 | 4432 | 6144 |
| 1953 | Oct 1-7 | July 29-Aug 5 | 19232 | 4954 | 1953 | July 29-Aug 5 | Sept 17-23 | 4815 | 8646 |
| 1954 | Oct 1-7 | July 29-Aug 5 | 24412 | 4962 | 1954 | July 29-Aug 5 | Sept 3-9 | 6708 | 8653 |
| 1955 | July 15-21 | Aug 27-Sept 2 | 27828 | 5133 | 1955 | July 29-Aug 5 | Aug 27-Sept 2 | 25157 | 8152 |
| 1956 | Oct 1-7 | July 15-21 | 25380 | 4802 | 1956 | July 29-Aug 5 | Aug 6-12 | 19167 | 7970 |
| 1957 | Oct 1-7 | July 22-28 | 19675 | 4794 | 1957 | July 29-Aug 5 | Sept 24-30 | 10937 | 9840 |
| 1958 | Oct 1-7 | July 29-Aug 5 | 27974 | 4974 | 1958 | July 29-Aug 5 | July 29-Aug 5 | 3938 | 3734 |
| 1959 | July 22-28 | Aug 20-26 | 28535 | 5044 | 1959 | July 29-Aug 5 | Aug 27-Sept 2 | 28442 | 8156 |
| 1960 | Oct 1-7 | Sept 10-16 | 21825 | 5474 | 1960 | July 29-Aug 5 | Sept 24-30 | 5535 | 9825 |
| 1961 | Oct 1-7 | July 22-28 | 19635 | 4794 | 1961 | Oct 1-7 | Aug 20-26 | 8909 | 7960 |
| 1962 | Oct 1-7 | July 1-7 | 20847 | 4796 | 1962 | July 29-Aug 5 | Aug 27-Sept 2 | 13988 | 8110 |
| 1963 | Oct 1-7 | July 8-14 | 28135 | 4814 | 1963 | Aug 6-12 | Aug 6-12 | 13830 | 7958 |
| 1964 | Oct 1-7 | July 8-14 | 19864 | 4794 | 1964 | Aug 27-Sept 2 | Aug 27-Sept 2 | 3003 | 8225 |
| 1965 | Oct 1-7 | Aug 13-19 | 23634 | 5026 | 1965 | Aug 20-26 | Sept 24-30 | 13772 | 9849 |
| 1966 | Oct 1-7 | July 29-Aug 5 | 21465 | 4958 | 1966 | Oct 1-7 | Aug 6-12 | 4433 | 6266 |
| 1967 | July 15-21 | Aug 13-19 | 29628 | 5056 | 1967 | Aug 13-19 | Aug 13-19 | 29636 | 8026 |
| 1968 | July 1-7 | July 8-14 | 20469 | 4795 | 1968 | Aug 27-Sept 2 | Aug 27-Sept 2 | 3003 | 8234 |
| 1969 | July 29-Aug 5 | Aug 20-26 | 6506 | 5154 | 1969 | - | - | - | - |
| 1970 | Aug 6-12 | Aug 27-Sept 2 | 5926 | 5291 | 1970 | July 29-Aug 5 | Aug 6-12 | 4327 | 6374 |
| 1971 | Aug 6-12 | Aug 20-26 | 18118 | 5017 | 1971 | July 29-Aug 5 | Aug 20-26 | 15175 | 7960 |
| 1972 | Oct 1-7 | June 24-30 | 19313 | 4954 | 1972 | Aug 13-19 | Aug 20-26 | 11109 | 7951 |
| 1973 | Aug 6-12 | Aug 27-Sept 2 | 16744 | 5111 | 1973 | - | - | - | - |
| 1974 | Aug 6-12 | Aug 20-26 | 6198 | 5084 | 1974 | - | - | - | - |
| 1975 | July 8-14 | July 15-21 | 21936 | 4797 | 1975 | Aug 20-26 | Sept 17-23 | 8912 | 8659 |
| 1976 | Oct 1-7 | Aug 6-12 | 18182 | 5023 | 1976 | July 29-Aug 5 | Aug 6-12 | 4259 | 6167 |
| 1977 | July 1-7 | July 15-21 | 19272 | 4793 | 1977 | Aug 20-26 | Aug 27-Sept 2 | 3129 | 8161 |
| 1978 | Oct 1-7 | Aug 6-12 | 13020 | 5009 | 1978 | July 29-Aug 5 | Aug 6-12 | 4255 | 6660 |
| 1979 | July 15-21 | July 22-28 | 25811 | 4803 | 1979 | Aug 20-26 | Aug 27-Sept 2 | 3770 | 8095 |
| 1980 | Oct 1-7 | July 15-21 | 26847 | 4805 | 1980 | Aug 13-19 | Aug 20-26 | 10807 | 7949 |
| 1981 | Oct 1-7 | Aug 13-19 | 30428 | 5058 | 1981 | Aug 6-12 | Aug 13-19 | 30439 | 8005 |
| 1982 | Oct 1-7 | July 22-28 | 20883 | 4795 | 1982 | July 29-Aug 5 | Aug 6-12 | 4494 | 6693 |
| 1983 | Oct 1-7 | Aug 6-12 | 20056 | 5020 | 1983 | July 29-Aug 5 | Sept 3-9 | 7828 | 8664 |




WEEKLY CONE VALVE OPERATION - LOAD YEAR 2002

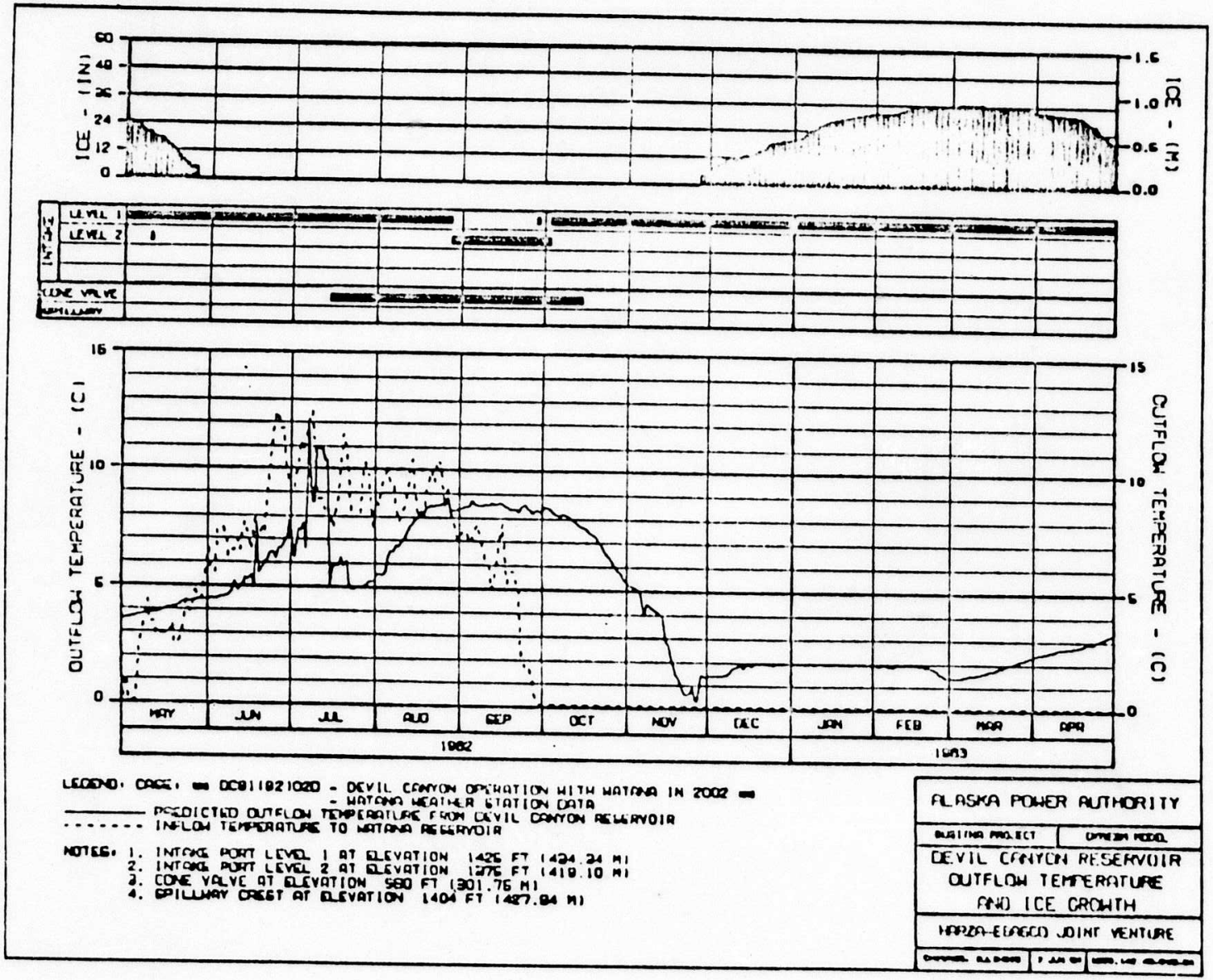
[redacted]

EXHIBIT 17




WEEKLY CONE VALVE OPERATION - LOAD YEAR 2020

EXHIBIT 18


ICE - (IN)
60
48
36
24
12
0
ICE - (M)
1.5
1.0
0.5
0.0
INTAKE
LEVEL 1
LEVEL 2
CONE VALVE
SPILLWAY
OUTFLOW TEMPERATURE - (C)
15
10
5
0
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
1982
1983
LEGEND: CASE: DC811821020 - DEVIL CANYON OPERATION WITH WATANA IN 2002
- WATANA WEATHER STATION DATA
PREDICTED OUTFLOW TEMPERATURE FROM DEVIL CANYON RESERVOIR
INFLOW TEMPERATURE TO WATANA RESERVOIR
NOTES: 1. INTAKE PORT LEVEL 1 AT ELEVATION 1425 FT (434.34 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 1275 FT (418.10 M)
3. CONE VALVE AT ELEVATION 980 FT (301.75 M)
4. SPILLWAY CREST AT ELEVATION 1404 FT (427.84 M)
ALASKA POWER AUTHORITY
WATANA PROJECT
DEVIL CANYON RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH
HARZA-EBASCO JOINT VENTURE

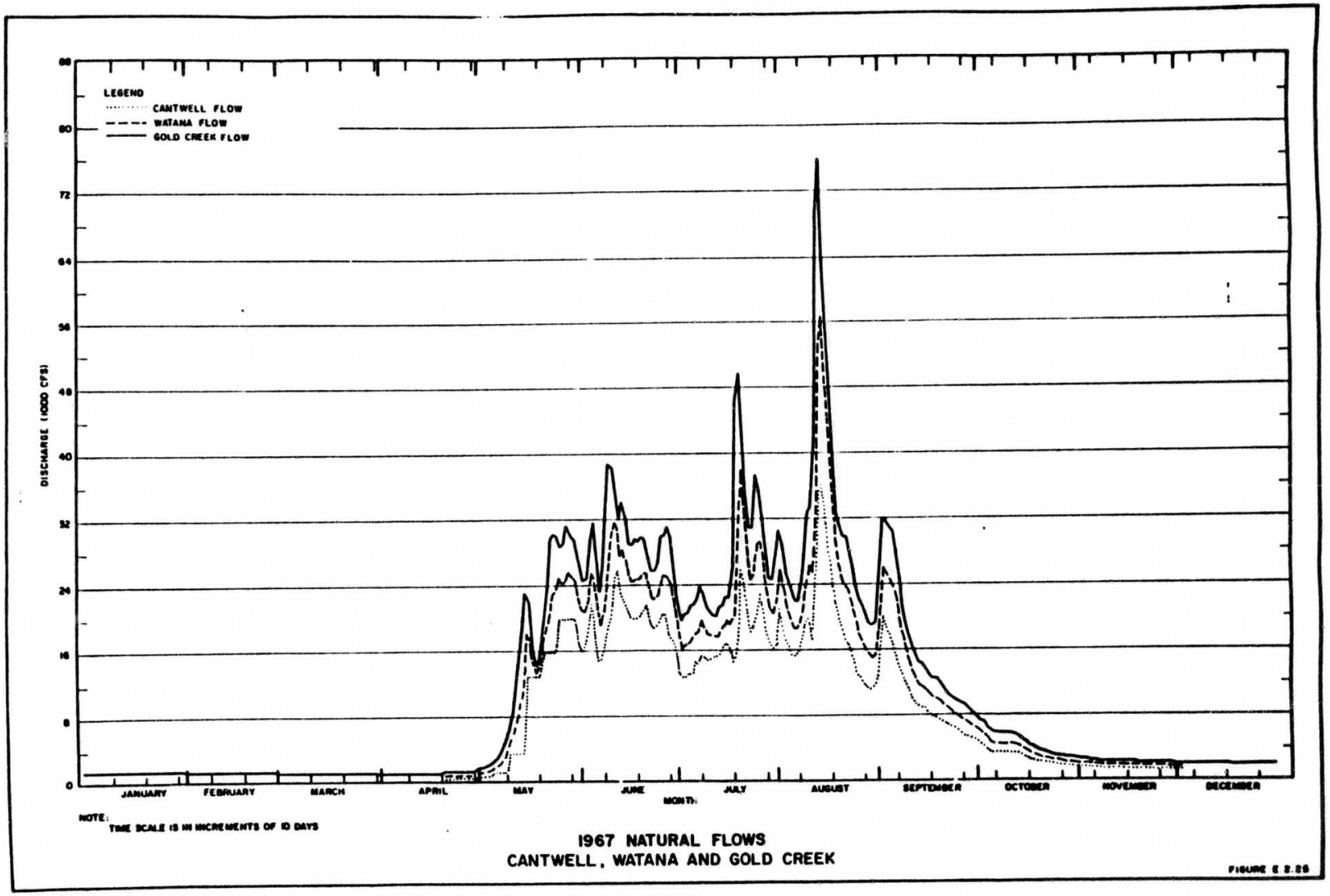
[redacted]

## Morphological and Hydrological Features - Watana Reservoir

| | |
|---|---|
| Elevation (maximum surcharge level) | 2201 MSL (671 m) |
| (normal maximum level) | 2185 MSL (666 m) |
| (minimum operating level) | 2065 MSL (630 m) |
| Normal Drawdown | 120 feet (36.6 m) |
| Live Storage | $3.7 \times 10^6$ acre-ft. ($4.6 \times 10^9$ $m^3$) |
| Maximum Surface Area | 38,000 acres (60 $mi^2$) |
| Maximum Length | approx. 48 miles (77 km) |
| Maximum Depth | 735 ft. (223 m) |
| Mean Depth | 250 ft. (76 m) |
| Gross Storage (total volume) | $9.5 \times 10^6$ acre-ft. ($11.7 \times 10^9$ $m^3$) |
| Shoreline Length | 183 miles (295 km) |
| Mean Hydraulic Residence Time | 1.65 years |
| Drainage Basin | 5,180 $mi.^2$ (13,416 $km^2$) |
| Mean River Inflow | 7,990 CFS (226 $m^3s^{-1}$) |
| Peak Flood Inflows | |
| PMF | 326,000 CFS (9,226 $m^3s^{-1}$) |
| 10,000 yr. | 156,000 CFS (4,415 $m^3s^{-1}$) |
| 50 yr. | 87,000 CFS (2,462 $m^3s^{-1}$) |
| 25 yr. | 76,000 CFS (2,151 $m^3s^{-1}$) |
| Tailwater Elevation | 1455 ft. MSL (443.5 m) |

## Morphological and Hydrological Features - Devil Canyon Reservoir

| | |
|---|---|
| Elevation (maximum surcharge level) | 1466 MSL (446.8 m) |
| (normal maximum level) | 1455 MSL (443.5 m) |
| (minimum operating level) | 1405 MSL (428.2 m) |
| Normal Drawdown | 50 ft. (15.2 m) |
| Live Storage | 350,000 acre-ft. (432 X $10^6 m^3$) |
| Maximum Surface Area | 7,800 acres (12 $mi.^2$) |
| Maximum Length | 26 mi. (42 km) |
| Maximum Depth | 565 ft. (171 m) |
| Mean Depth | 140 ft. (42 m) |
| Gross Storage (total volume) | 1.1 X $10^6$ acre-ft. (1.4 X $10^9 m^3$) |
| Shoreline Length | 76 mi. (123 km) |
| Mean Hydraulic Residence Time | approx. 60 days |
| Drainage Basin | 5,810 $mi.^2$ (15,048 $km^2$) |
| Mean River Inflow | 9,080 CFS (256 $m^3 s^{-1}$) |
| Peak Flood Inflows | |
| PMF | 345,000 CFS (w/Watana) |
| 10,000 yr. | 165,000 CFS (w/Watana) |
| 50 yr. | 39,000 CFS (w/Watana) |
| 25 yr. | 37,800 CFS (w/Watana) |
| Tailwater Elevation | 850 ft. MSL |




1967 NATURAL FLOWS
CANTWELL, WATANA AND GOLD CREEK

FIGURE E 2.25

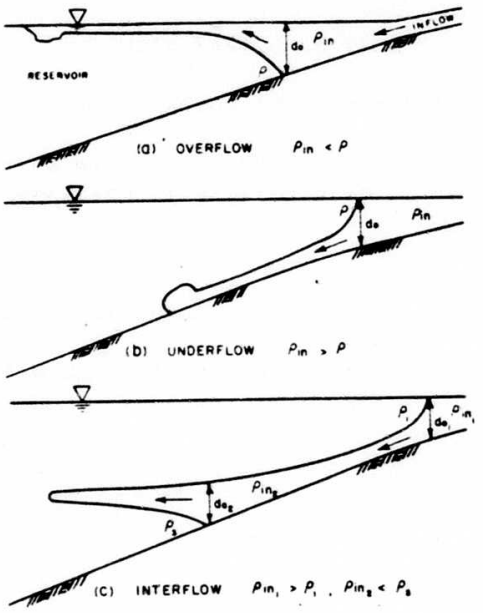



**Figure 7–18** Types of inflow into lakes and reservoirs. (From Wunderlich, W. O.: The dynamics of density-stratified reservoirs. *In* Hall, G. E., ed., Reservoir Fisheries and Limnology. Washington, D.C., American Fisheries Society, 1971.)

Table

SUSITNA HYDROELECTRIC PROJECT

Key Limnological Limitations for Water Quality

Temperature

Turbidity

Depth

Large Volume vs. Small Surface Area

Large Volume for Dilution of Leachates

Short Average Hydraulic Residence Time

Surface Withdrawal of Water (Predominately)

Long and Narrow with Small Surface for Wind Circulation - better sedimentation of particulates

Sediment "Blanket" Effect

Very Small Littoral Zone

Little or no Human Induced Nutrient Additions

Table

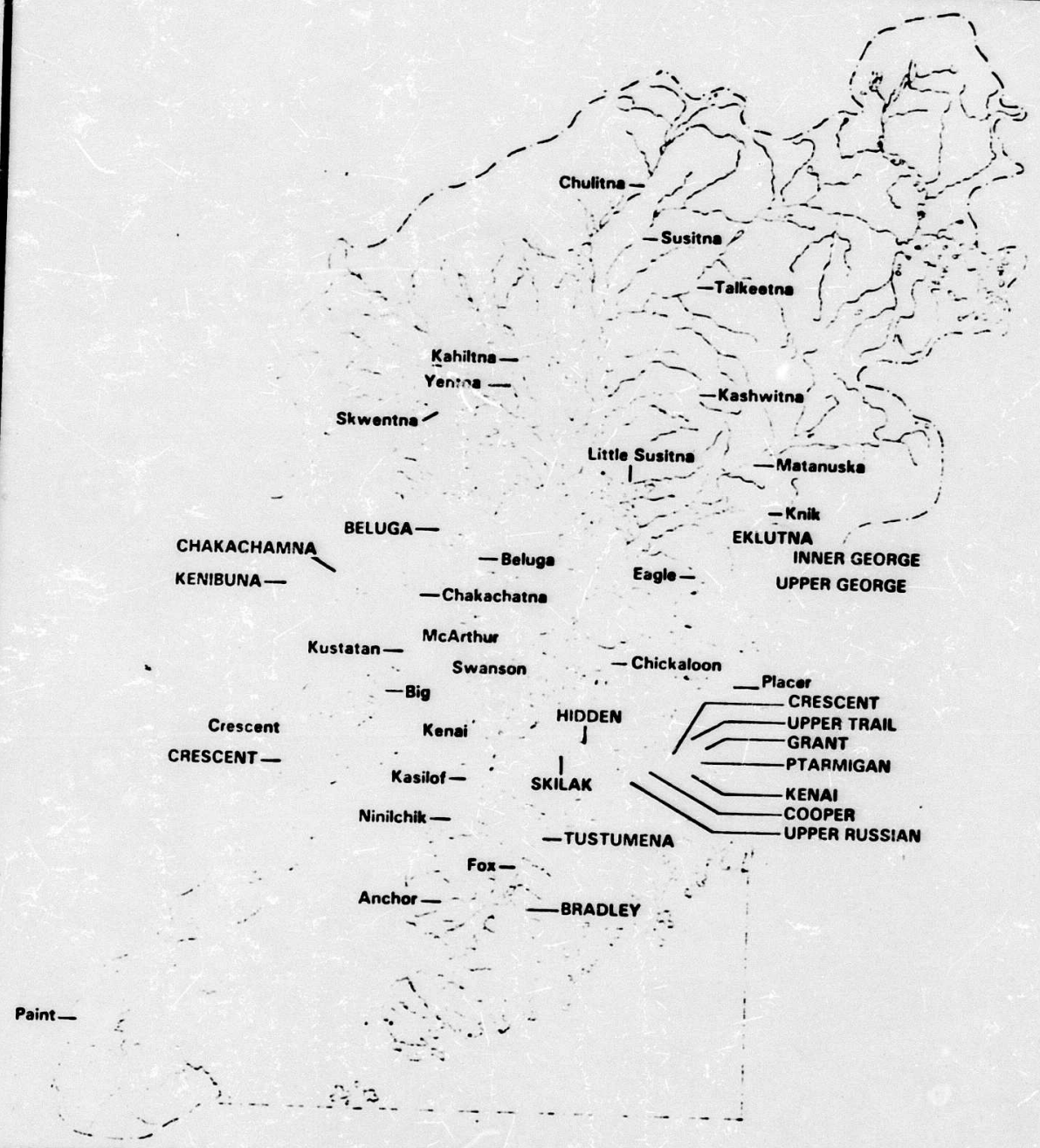
SUSITNA HYDROELECTRIC PROJECT

Estimated Water Quality Characteristics of Susitna Hydroelectric Project Reservoirs

| | | |
|---|---|---|
| Trophic Status | Ultraoligotrophic-to-Oligotrophic (slight upsurge for @ 10 yrs.) | 10-200mgC $m^{-2}$ $day^{-1}$ |
| Phytoplankton Standing Crop | <1.0mg $m^{-3}$ | |
| Phytoplankton Density | <1.0 $cm^3$ $m^{-3}$ | |
| Chlorophyll a | <0.25mg $m^{-3}$ | |
| Dominant Phytoplankton | Bacillariophyceae, Chrysophyceae, Dinophyceae | |
| Euphotic Zone (1% PAR) | 0.1m ---> 4.0m | |
| Total Organic Carbon | Slight Increase (5-10 yrs) --->then Decrease | |
| Total Biologically Available P | <20 $ugl^{-1}$ | |
| Total Nitrate Nitrogen | <250 $ugl^{-1}$ | |
| Total Suspended Solids | 0-300 $mgl^{-1}$ (at present estimate) | |
| pH | 7.0+ | |
| Alkalinity | 65 mg $CaCO_3$ | |
| Conductivity | 150 umhos $cm^{-2}$ | |
| Dissolved Oxygen | 8.0+ ; 50-100% saturation | |

## SURFACE WATERS

**EXHIBIT-E**



Table

SUSITNA HYDROELECTRIC PROJECT

Some Estimated Downstream Water Quality Trends: With - Project vs. Natural

| | Summer May - September | Winter October - April |
|---|---|---|
| Settleable Solids | Much Less | More |
| TSS | Much lower | Much Higher |
| Turbidity | Lower | Much Higher |
| Nutrients: | | |
| 1. Phosphorus | | |
| Total | Much Less | Much More |
| BAP-Organic | More | More |
| BAP-Inorg. | Little Change | Little Change |
| 2. Organic Carbon | Less | Higher |
| Labile | More | More |
| Refractory | Less | More |
| 3. Oxygen | Little Change | Little Change |
| 4. Nitrogen | Less | More |
| Most Metals | Much Less | More |
| Conductivity | Higher | Lower |

Total Dissolved Solids (slight increase during trophic upsurge, then more seasonally stabilized)

## FACTORS AFFECTING PRIMARY PRODUCTION

NUTRIENTS
HEAVY METALS
TURBIDITY/LIGHT PENETRATION
} SUSPENDED SEDIMENT LOAD

VELOCITY

SUBSTRATE STABILITY

TEMPERATURE

## CONCLUSIONS

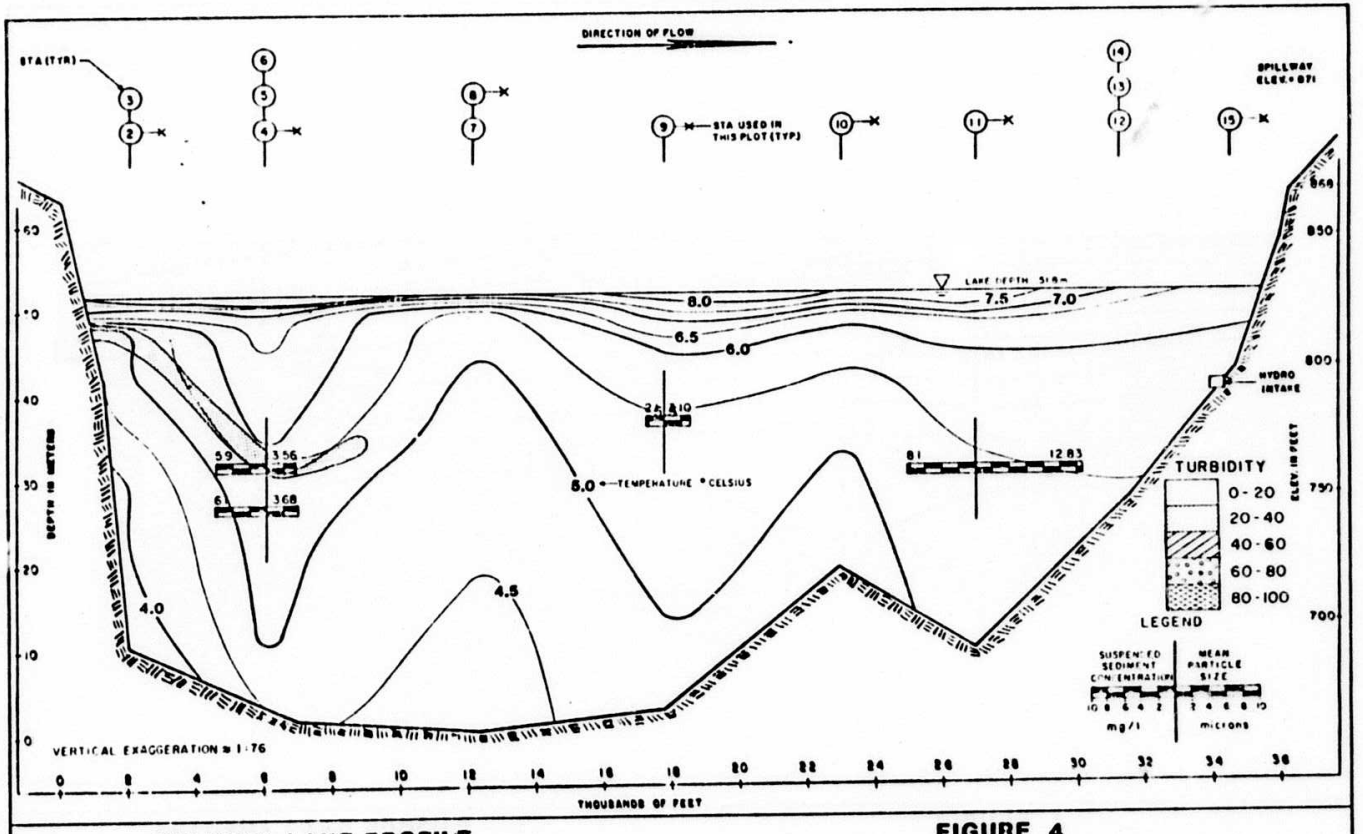
NUTRIENTS WILL REMAIN ABUNDANT

PRIMARY PRODUCTION IS PRESENTLY LIMITED BY LIGHT AND VELOCITY

PRIMARY PRODUCTION MAY INCREASE UNDER POST-PROJECT CONDITIONS BECAUSE OF LOWER, MORE STABLE FLOWS AND DECREASED TURBIDITIES

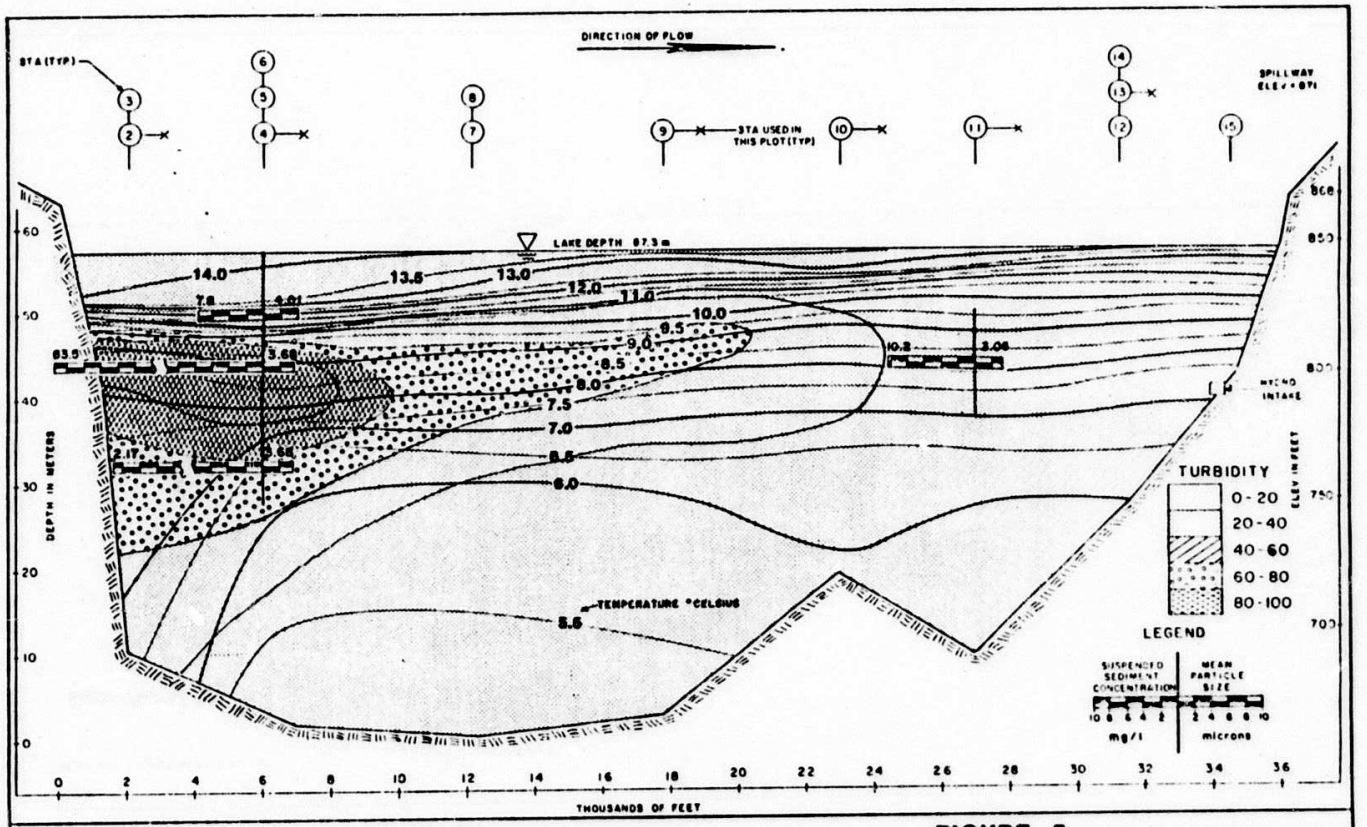
TABLE 1.1

| | Watana Reservoir | Eklutna Lake |
|---|---|---|
| Surface Area | 37,800 acres | 3427 acres |
| Maximum Depth | 860 feet | 208 feet |
| Drainage Area | 5,180 sq. mi. | 111 sq. mi. |
| Average Annual Inflow | 5,880,000 acre-ft | 234,300 acre-ft |
| Average Residence Time | 1.65 years | 1.77 years |
| % Glaciated Drainage Area | 5.9% | 5.2% |



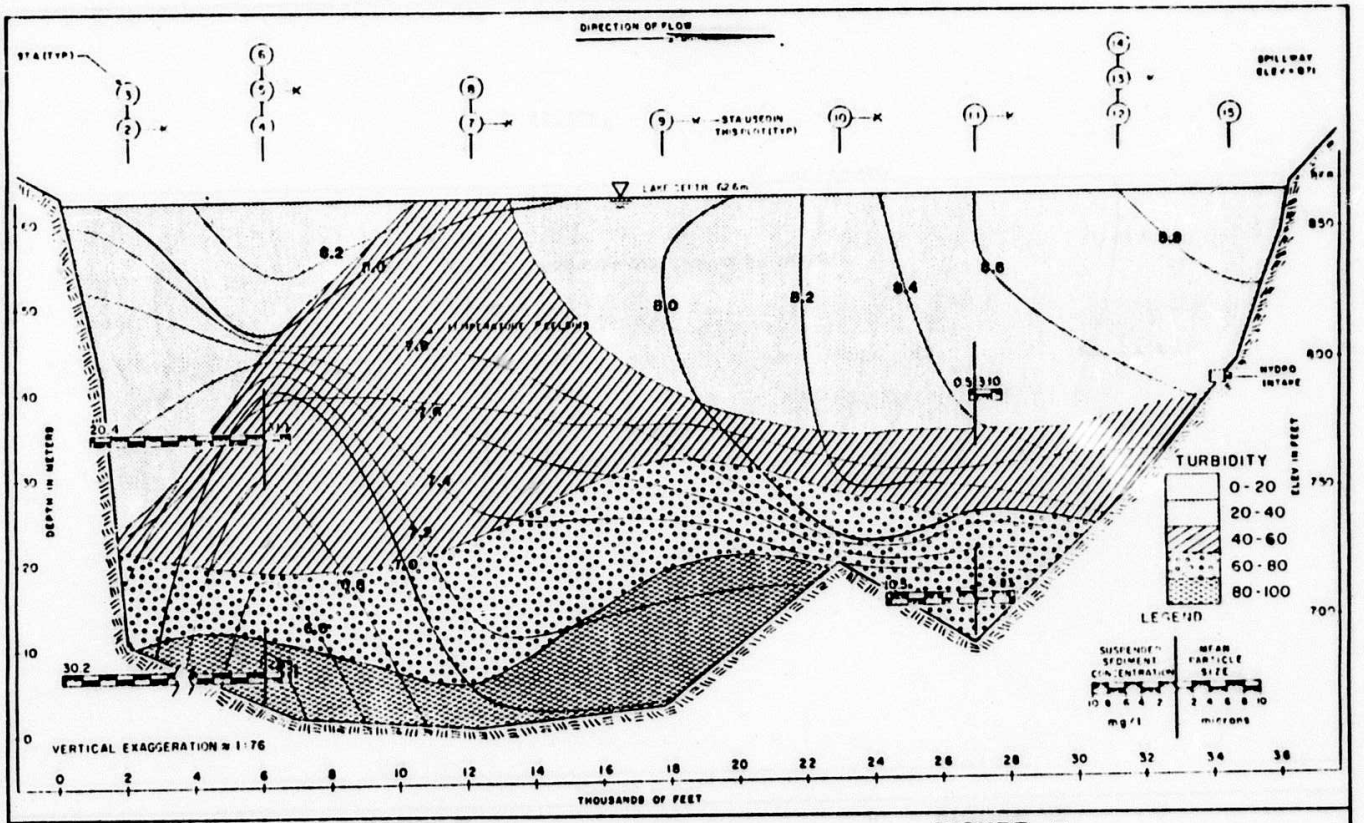

**EKLUTNA LAKE PROFILE** **FIGURE 4**

**SUSPENDED SEDIMENT 18 JUNE 82** **SOURCE: R&M CONSULTANTS, INC. (1982b)**




**EKLUTNA LAKE PROFILE** **FIGURE 5**

**SUSPENDED SEDIMENT 28 JULY 82** **SOURCE: R&M CONSULTANTS, INC. (1982b)**

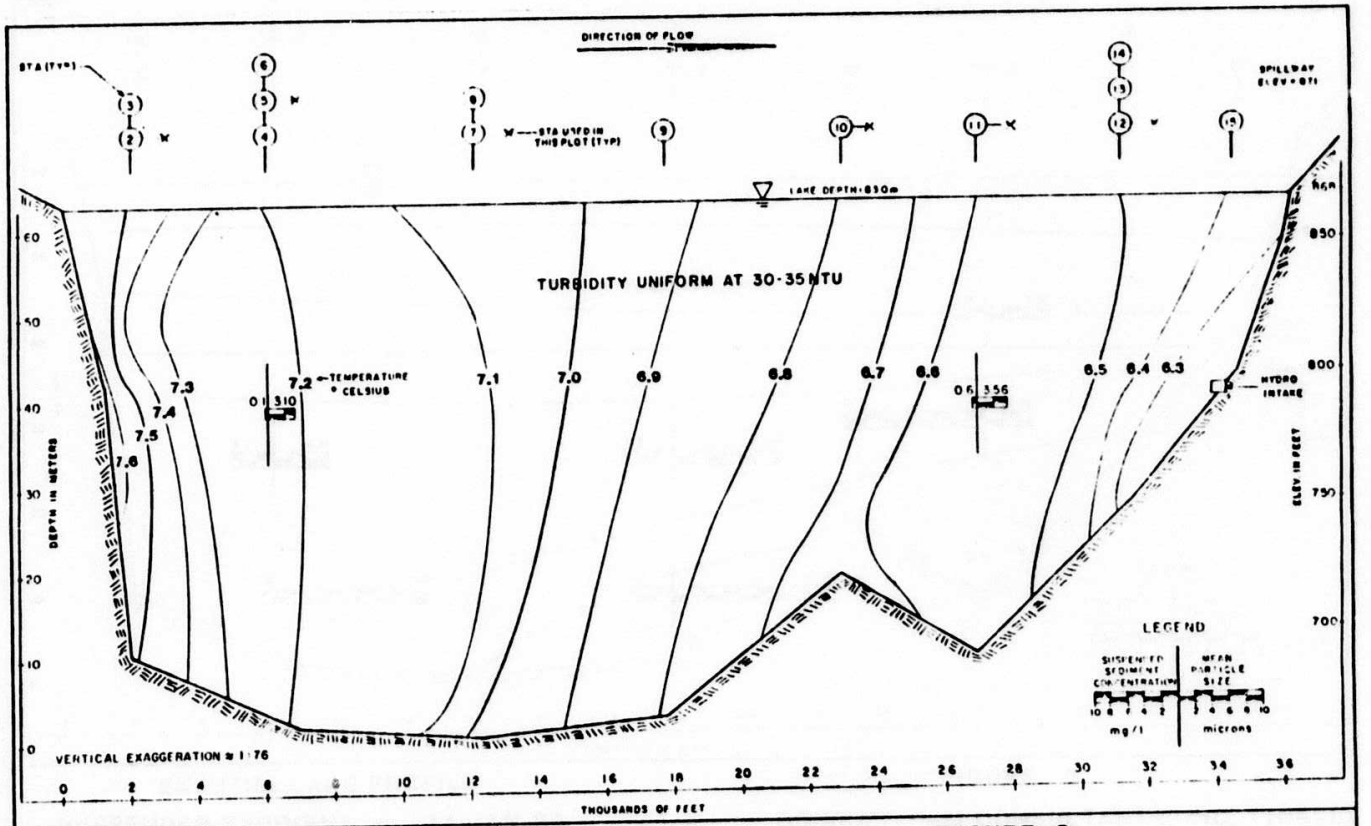



**EKLUTNA LAKE PROFILE**

**SUSPENDED SEDIMENT 22 SEPT 82**

**FIGURE 7**

**SOURCE: R&M CONSULTANTS, INC. (1982b)**

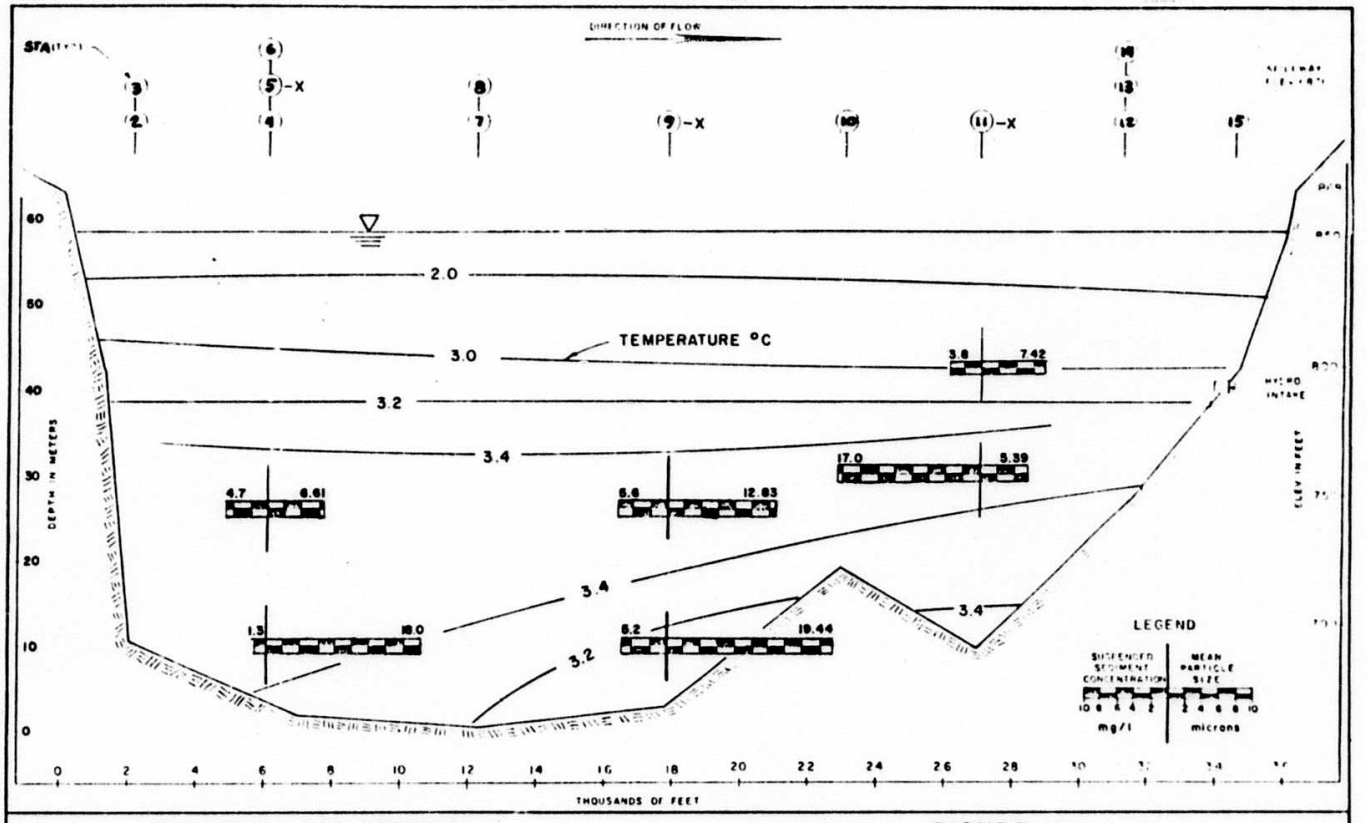



**EKLUTNA LAKE PROFILE**

**SUSPENDED SEDIMENT 14 OCT 82**

**FIGURE 8**

**SOURCE: R&M CONSULTANTS, INC. (1982b)**




**EKLUTNA LAKE PROFILE** **FIGURE 9**

**SUSPENDED SEDIMENT 11 JAN 83** **SOURCE: R&M CONSULTANTS, INC. (1982b)**

TABLE 4.2
PETROGRAPHIC ANALYSIS

| Mineral Species | % of Total Sediment | |
|---|---|---|
| | Susitna River at Gold Greek | Eklutna Lake Composite |
| Augite | 5 - 10 | 5 |
| Quartz | 15 - 20 | 15 - 20 |
| Diatoms | 5 | 1 - 2 |
| Muscovite | 19 - 20 | 15 - 20 |
| Mixed Feldspars | 25 - 30 | 30 - 35 |
| Iron Oxides | 10 - 15 | 4 - 8 |
| Illmenite | 5 | 3 |
| Calcite | 1 - 2 | 2 - 3 |
| Zircon | 1 | --- |
| Pyrite | 3 - 5 | 1 |

TABLE 1

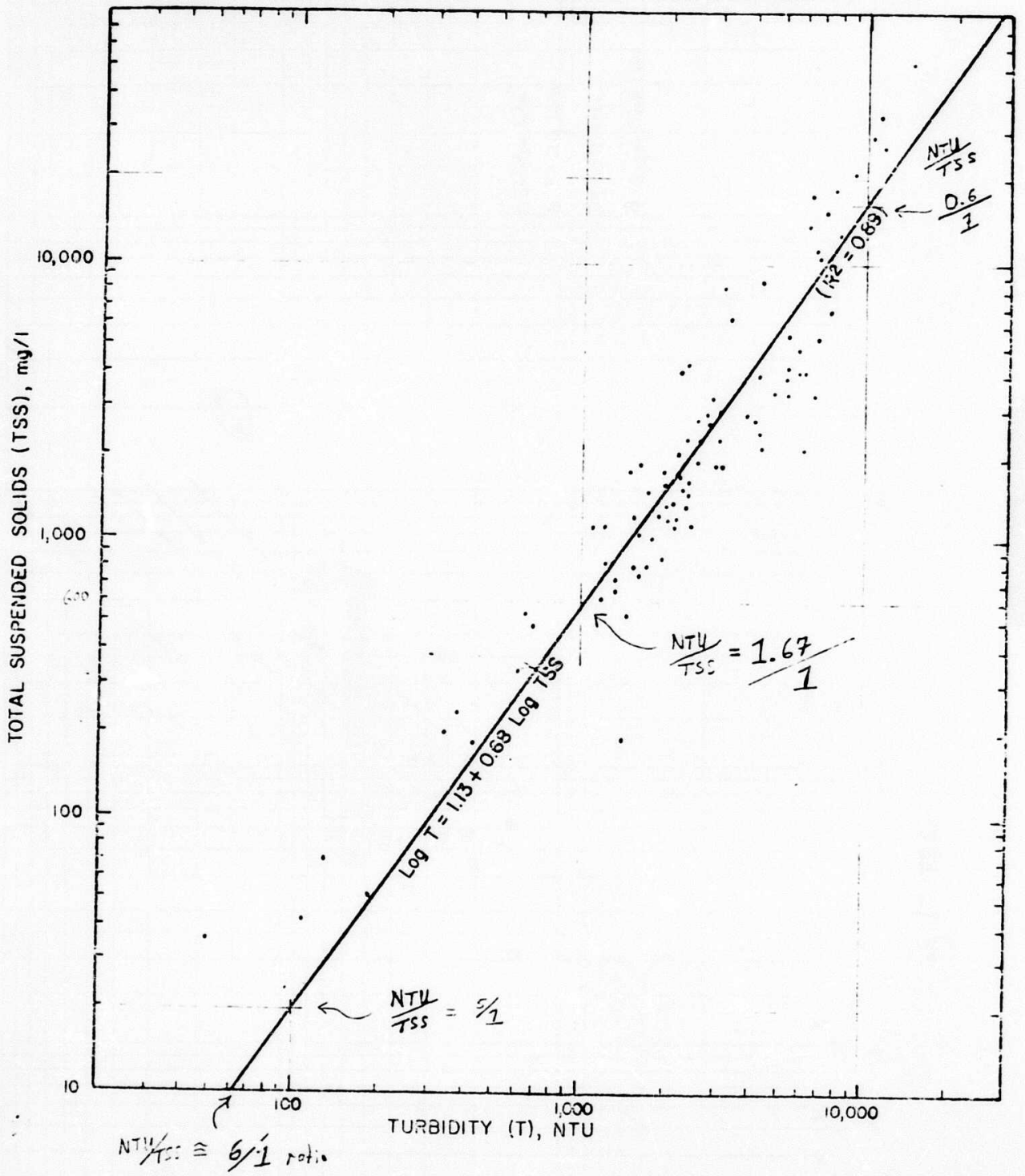
AVERAGE TOTAL SUSPENDED SOLIDS AND TURBIDITY VALUES
SETTLING COLUMN TESTS

| | 0 HOUR | | | 6 HOUR | | | 12 HOUR | | | 24 HOUR | | | 48 HOUR | | | 72 HOUR | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MINE SITE | TSS mg/l | Turb NTU | NTU/TSS | TSS mg/l | Turb NTU | NTU/TSS | TSS mg/l | Turb NTU | NTU/TSS | TSS mg/l | Turb NTU | NTU/TSS | TSS mg/l | Turb NTU | NTU/TSS | TSS mg/l | Turb NTU | NTU/TSS |
| 1 | 6,280 | 3,200 | .51 | 2,310 | 2,900 | 1.25 | 2,060 | 2,200 | 1.07 | 1,260 | 1,900 | 1.51 | 1,240 | 1,500 | 1.21 | 780 | 1,500 | 1.94 |
| 2 | 53,800 | 14,200 | .26 | 15,300 | 7,100 | 0.46 | 4,100 | 5,400 | 1.32 | 1,800 | 2,900 | 1.61 | 800 | 1,700 | 2.13 | 620 | 1,200 | 1.94 |
| 3 | 11,200 | 6,700 | .60 | 3,410 | 6,500 | 1.9 | 4,080 | 5,300 | 1.30 | 3,600 | 5,200 | 1.44 | 3,400 | 4,700 | 1.38 | 2,800 | 3,700 | 1.32 |
| 4 | 33,500 | 10,700 | .32 | 5,310 | 6,800 | 1.28 | 2,690 | 4,000 | 1.49 | 1,430 | 2,300 | 1.60 | 540 | 1,300 | 2.41 | 190 | 1,400 | 7.37 |
| 5 | 5,480 | 5,300 | .97 | 3,990 | 4,200 | 1.05 | 3,260 | 2,900 | 0.89 | 1,840 | 2,900 | 1.57 | 1,280 | 2,300 | 1.80 | 1,000 | 1,700 | 1.70 |
| 6 | 8,100 | 3,100 | .38 | 4,250 | 2,300 | 0.54 | 1,850 | 1,600 | 0.86 | 1,410 | 1,300 | 0.92 | 1,130 | 1,100 | 0.97 | 810 | 1,200 | 1.48 |
| 7 | 17,200 | 6,300 | .37 | 2,760 | 2,800 | 1.01 | 1,730 | 2,200 | 1.27 | 1,320 | 2,000 | 1.52 | 1,030 | 1,600 | 1.55 | 1,160 | 1,980 | 1.71 |
| 8 | 13,700 | 6,100 | .45 | 2,900 | 3,600 | 1.24 | 2,290 | 2,500 | 1.09 | 1,850 | 2,500 | 1.35 | 1,590 | 1,900 | 1.11 | 1,130 | 1,200 | 1.06 |
| 9 | 12,700 | 7,900 | .62 | 2,710 | 4,800 | 1.77 | 1,130 | 2,100 | 1.86 | 700 | 1,280 | 1.83 | 330 | 600 | 1.82 | 180 | 420 | 2.33 |
| 10 | 18,100 | 7,400 | .41 | 4,950 | 5,600 | 1.13 | 3,770 | 5,100 | 1.35 | 3,480 | 5,100 | 1.47 | 2,430 | 3,600 | 1.48 | 2,290 | 3,000 | 1.31 |
| 11 | 3,030 | 2,700 | .89 | 1,780 | 2,400 | 1.35 | 1,470 | 1,700 | 1.16 | 1,280 | 2,000 | 1.56 | 1,350 | 2,600 | 1.93 | 1,170 | 2,000 | 1.71 |
| 12 | 20,700 | 8,500 | .41 | 6,550 | 6,800 | 1.04 | 4,180 | 5,300 | 1.27 | 2,180 | 4,300 | 1.97 | 1,840 | 3,100 | 1.68 | 1,110 | 2,400 | 2.16 |
| 13 | 27,900 | 10,200 | .37 | 1,470 | 1,800 | 1.22 | 490 | 680 | 1.39 | 200 | 330 | 1.65 | 52.3 | 180 | 3.44 | 42.9 | 110 | 2.56 |
| 14 | 25,600 | 11,100 | .43 | 10,400 | 6,800 | 0.65 | 534 | 630 | 1.18 | 232 | 370 | 1.59 | 68.8 | 130 | 1.89 | 35.2 | 45 | 1.28 |
| Porcupine | 8,610 | 4,300 | .50 | 2,830 | 2,800 | 0.99 | 1,630 | 2,300 | 1.41 | 873 | 1,500 | 1.72 | 740 | 1,400 | 1.89 | 651 | 1,300 | 2.0 |
| | | $n=15$ $\bar{x}=.50$ | | | $\bar{x}=1.13$ | | | $\bar{x}=1.26$ | | | $\bar{x}=1.55$ | | | $\bar{x}=1.78$ | | $n=15$ $\bar{x}=2.1$ | |

Note: The values listed above are average values of the column parts sampled.
Average values for Porcupine Creek listed under 6 hour and 12 hour were sampled at 4 and 7 hours, respectively.
Total Suspended Solids and Turbidity values for Porcupine Creek after 528 hours (22 days) are 120 mg/l and 390 NTU, respectively. $\frac{NTU}{TSS} = 3.25$

R&M

R&M CONSULTANTS, INC.

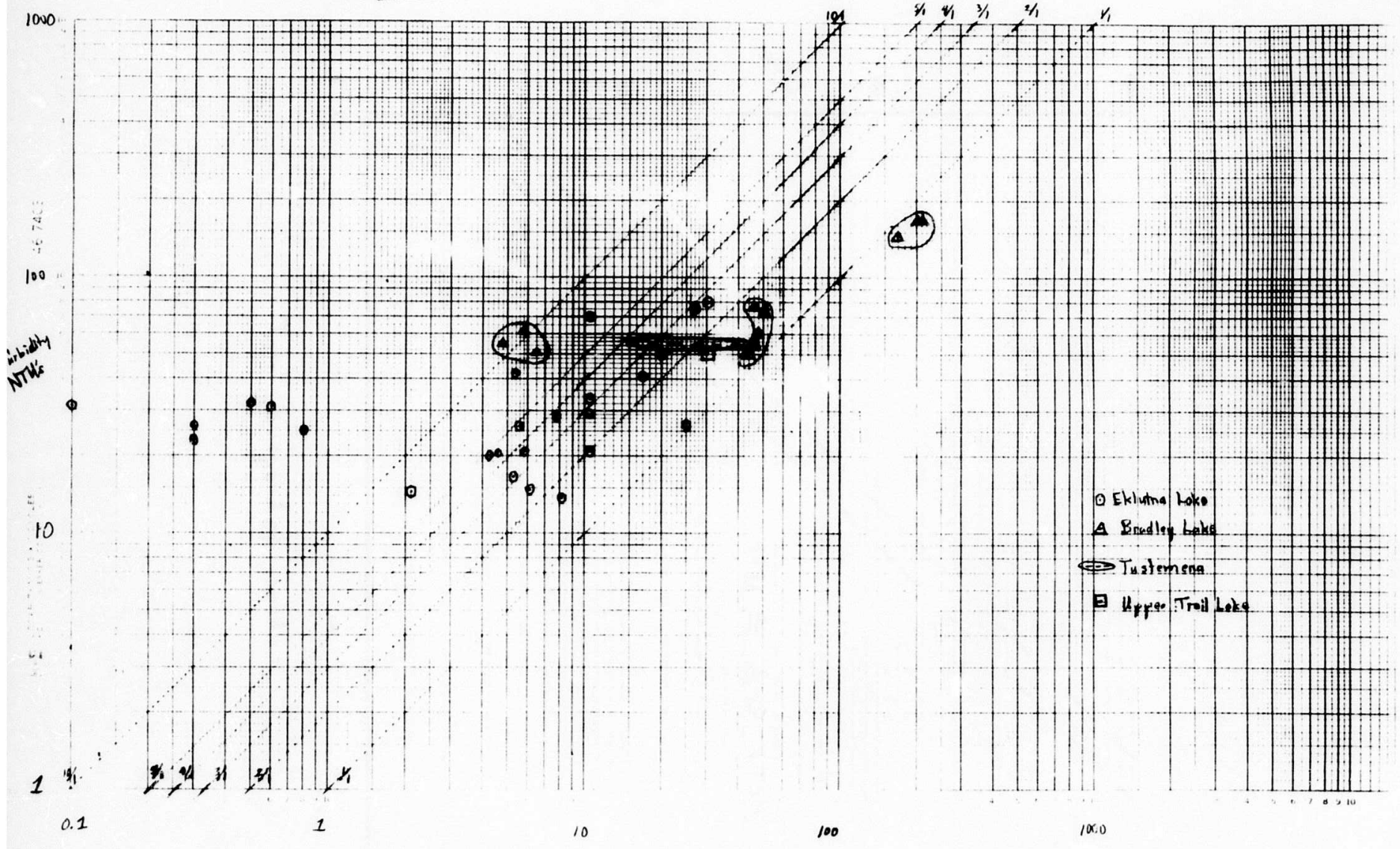



# RELATIONSHIP BETWEEN TURBIDITY AND TOTAL SUSPENDID SOLIDS

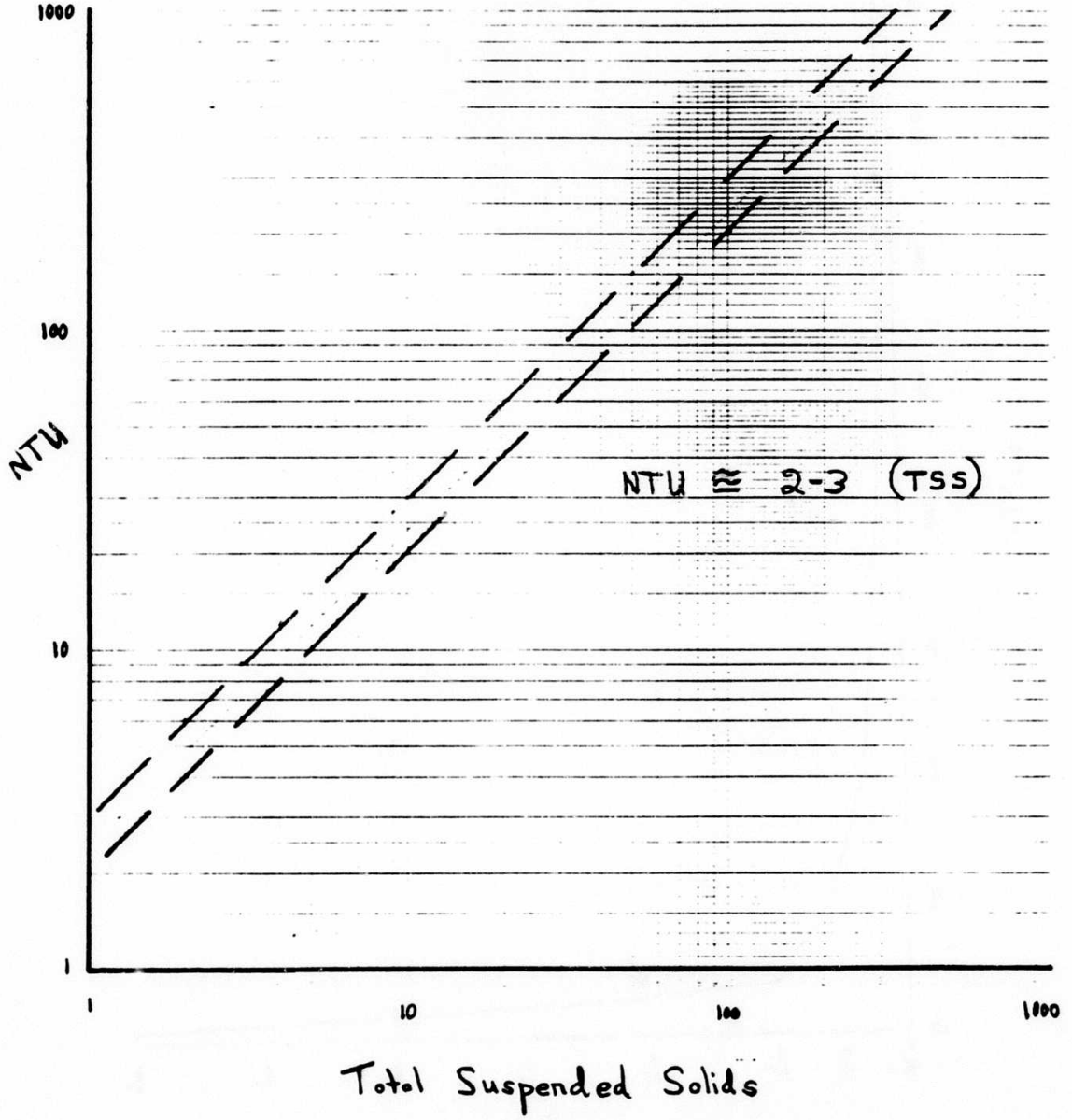
SETTLING POND DEMONSTRATION PROJECT

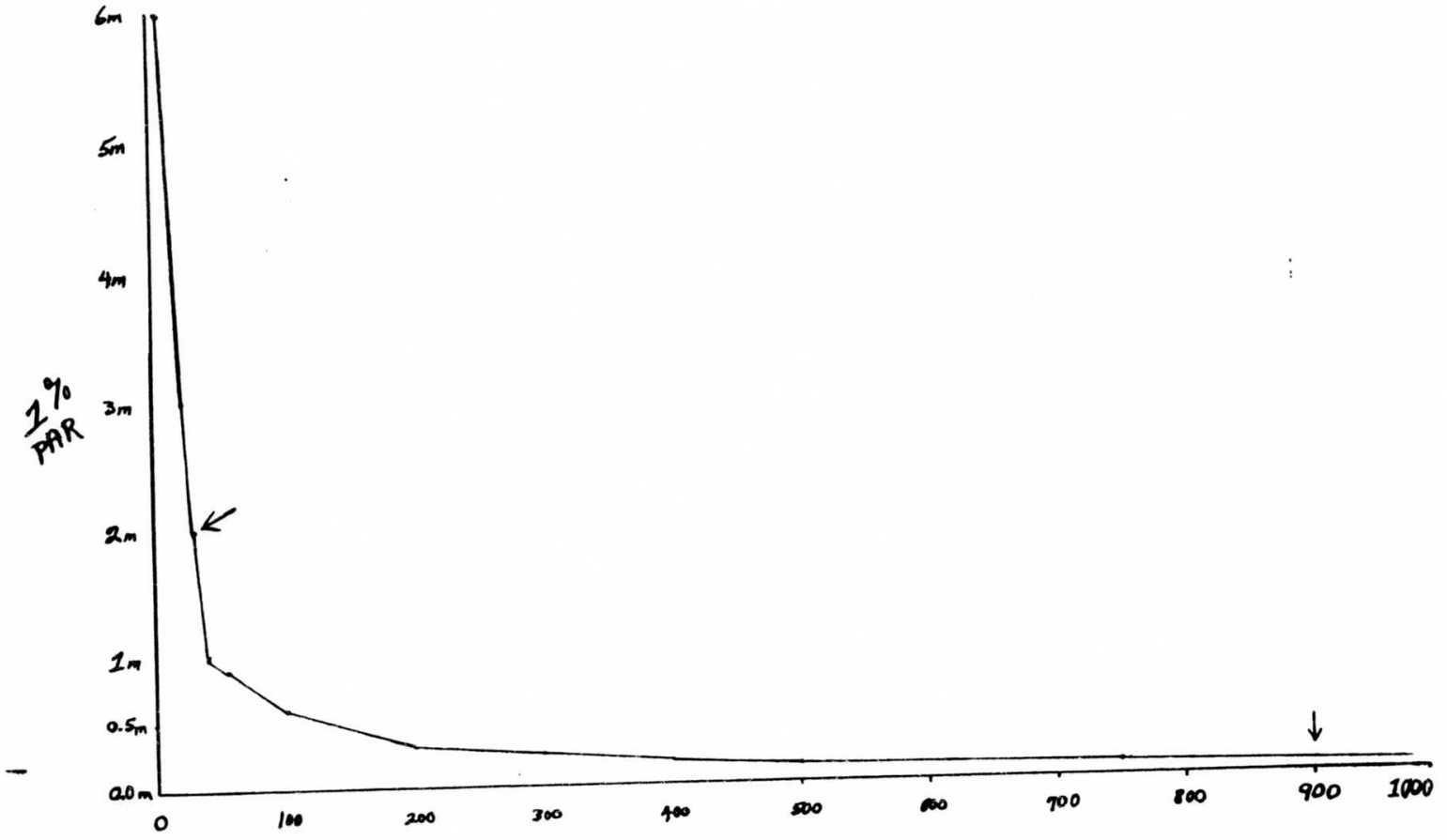
| DATE | SCALE | DRAWN BY | CHECKED BY | PROJECT NO. | DRAWING NO. |
|---|---|---|---|---|---|
| 6-6-62 | AS SHOWN | LDS | JHW | 013104 | 5 |

Glacial Lake Data




[redacted]


1000
100
10
1
NTU
NTU ≅ 2-3 (TSS)
1
10
100
1000
Total Suspended Solids


6m
5m
4m
3m
2m
1m
0.5m
0.0m
1% PAR
0
100
200
300
400
500
600
700
800
900
1000
NTU's

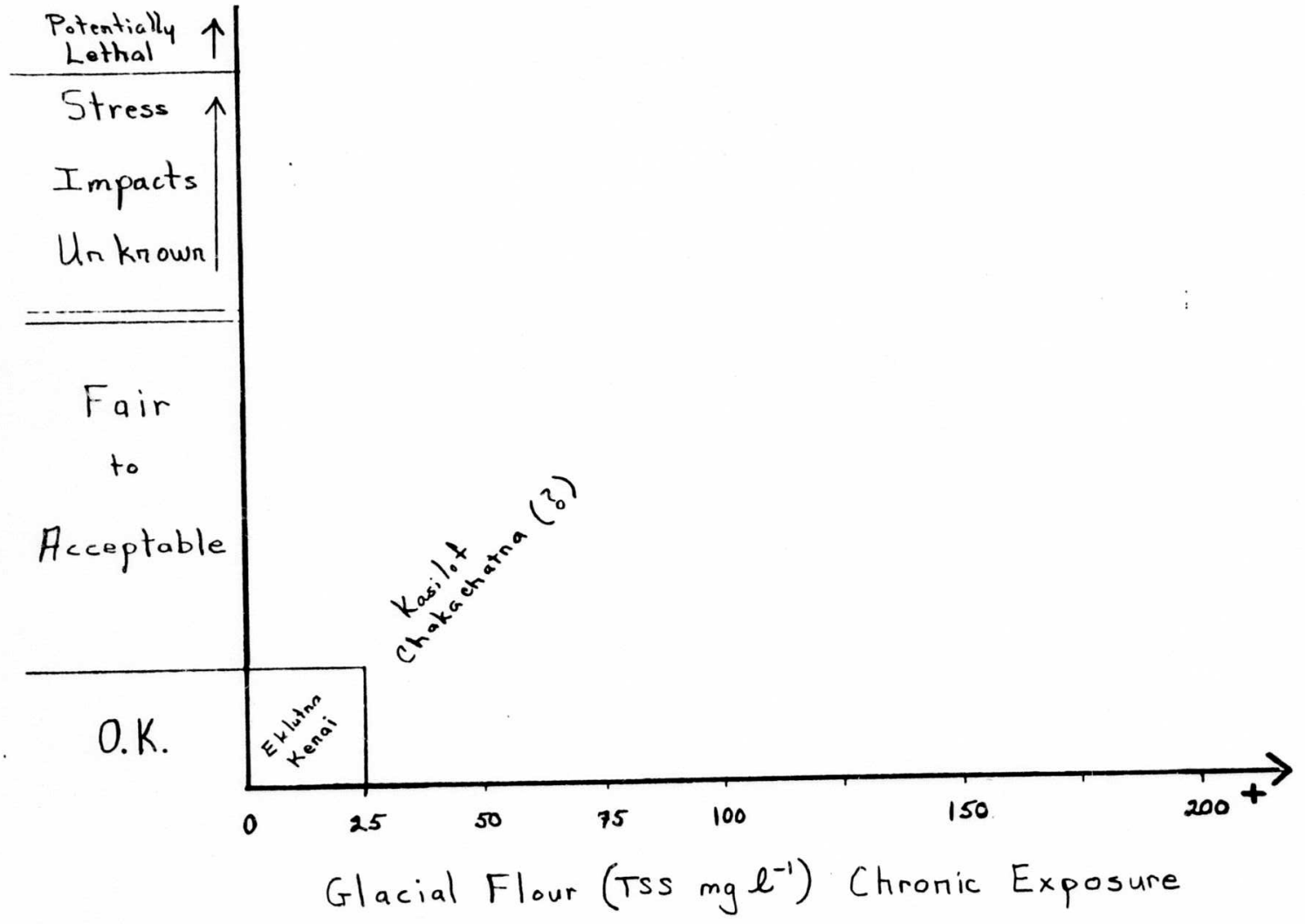

Potentially Lethal
Stress Impacts Unknown
Fair to Acceptable
O.K.
Kasilof
Chakachatna (?)
Eklutna
Kenai
0
25
50
75
100
150
200 +
Glacial Flour (TSS mg ℓ⁻¹) Chronic Exposure

**Table 1**

Mercury Physical and Chemical Characteristics

| Item | |
|---|---|
| Atomic weight | 200.59 |
| Melting point | -38.87° C |
| Boiling point | 356-358° C |
| Solubility in water | practically insoluble, 25 ppb as Hg |
| Specific gravity @ 20° C | 13.546 |
| Vapor pressure @ 20° C | 0.0012 mm Hg |
| Oxidation states | $H^{\circ}$, $Hg^{+}$, $Hg^{++}$ |

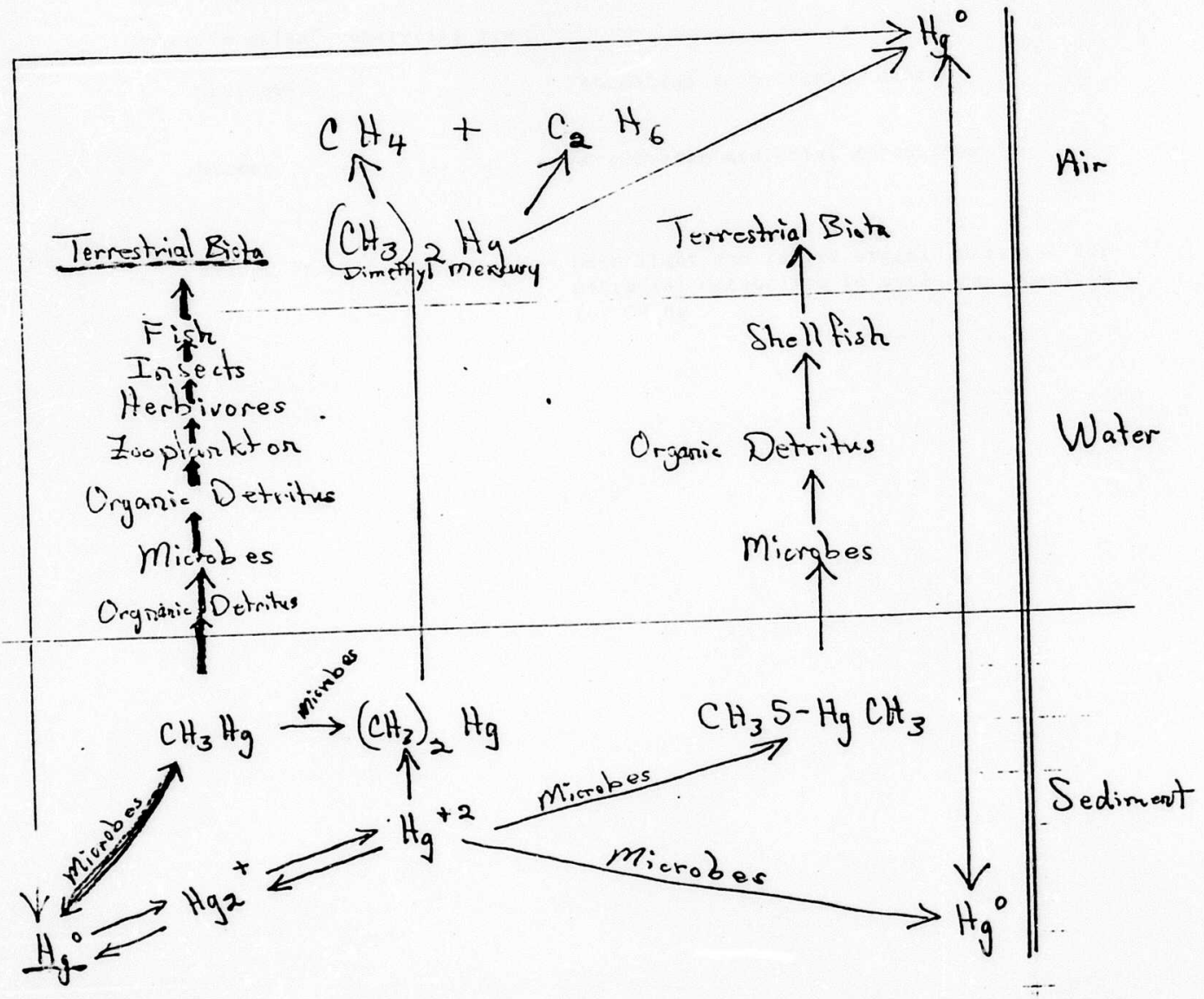



Figure 1.

A simplified representation of the mercury cycle demonstrating the flow of mercury and its bioaccumulation through the aquatic food chains.

## Selected Thoughts about Possible Limited Potential for Susitna Induced Mercury Bioccumulation

1. Limited Fishery in Reservoirs
2. Limited primarily to resident fish - Downstream
3. Other "problem" reservoirs are:

| | |
|---|---|
| Shallower | - Inundating much organic debris |
| Warmer | - Accelerates microbial metabolism |
| Richer Trophic Status | - More light and labile organic material for microbial metabolism to cycle and possibly for $CH_3Hg$ |

SUSITNA HYDROELECTRIC PROJECT

Status of Construction Permits
Water Quality Protection
July 30, 1984

## Applications Submitted

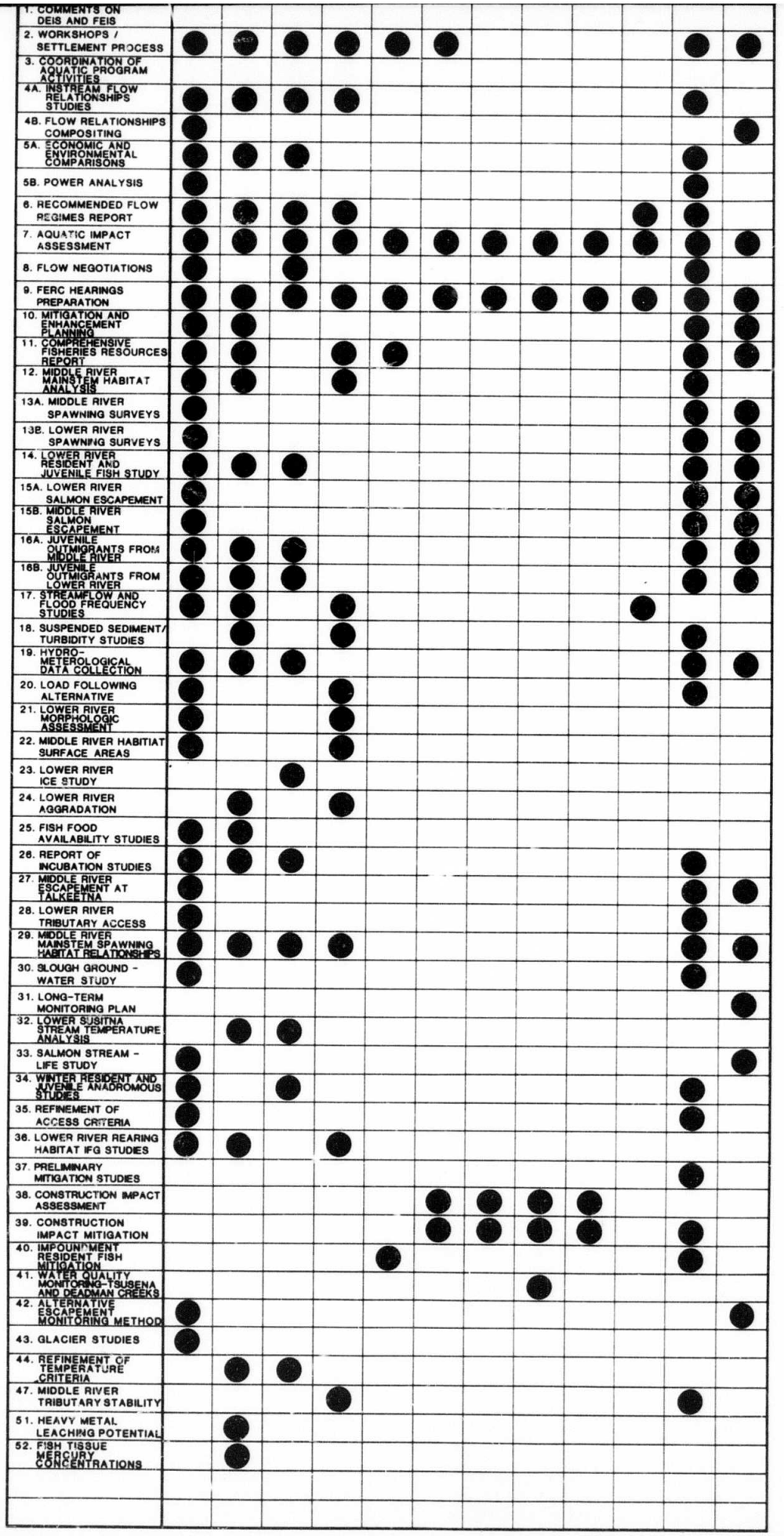
| | |
|---|---|
| Hydroelectric License | FERC |
| NPDES | EPA |
| Determination of Consistency w/Coastal Mgt. Program | OMB-DGC |
| Section 401, Cert. of Reas. Assurance w/Water Quality | ADEC |

## Applications Pending

| | |
|---|---|
| Section 10, Rivers & Harbor Act | COE |
| Section 404, Clean Water Act | COE |
| Solid Waste Management | ADEC |
| | MSB |
| | EPA |
| Wastewater Disposal | ADEC |
| | MSB |
| | EPA |
| AS 16.10.010, Work in Anad. Streams | ADEC |
| AS 16.10.020, " " " | ADHSS |
| AS 16.05.870, " " " | ADF&G |
| Approval to Construct/Operate (Potable Water) | ADEC |
| Toxic & Hazardous Waste Mgt., incl. Contingency Planning | EPA |
| | ADEC |
| Material Acquisition | BLM |
| | ADNR |
| | CIRI |

# RELATIONSHIP BETWEEN FY 85 AQUATIC PROGRAM WORK PLAN AND ISSUES

| TASKS | F-1 SIGNIFICANCE OF ALTERED FLOWS ON FISH | F-2 SIGNIFICANCE OF WATER QUALITY CHANGES | F-3 SIGNIFICANCE OF ALTERED ICE PROCESSES | F-4 SIGNIFICANCE OF CHANGES TO STREAM MORPHOLOGY | F-5 SIGNIFICANCE OF IMPOUNDMENT EFFECTS ON FISH | F-6 SIGNIFICANCE OF ACCESS CORRIDOR EFFECTS ON FISH | F-7 SIGNIFICANCE OF TRANSMISSION LINE EFFECTS ON FISH | F-8 SIGNIFICANCE OF WATER QUALITY EFFECTS DUE TO CAMP AND VILLAGE | F-9 SIGNIFICANCE OF WATER QUALITY EFFECTS IN BORROW AND SPOIL AREAS | F-10 SIGNIFICANCE OF INSTREAM ACTIVITIES ON FISH | F-11 FEASIBILITY OF MITIGATION OPTIONS | F-12 FORMULATION OF LONG-TERM MONITORING PLAN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. COMMENTS ON DEIS AND FEIS | | | | | | | | | | | | |
| 2. WORKSHOPS / SETTLEMENT PROCESS | ● | ● | ● | ● | ● | ● | | | | | ● | ● |
| 3. COORDINATION OF AQUATIC PROGRAM ACTIVITIES | | | | | | | | | | | | |
| 4A. INSTREAM FLOW RELATIONSHIPS STUDIES | ● | ● | ● | ● | | | | | | | ● | |
| 4B. FLOW RELATIONSHIPS COMPOSITING | ● | | | | | | | | | | | ● |
| 5A. ECONOMIC AND ENVIRONMENTAL COMPARISONS | ● | ● | ● | | | | | | | | ● | |
| 5B. POWER ANALYSIS | ● | | | | | | | | | | ● | |
| 6. RECOMMENDED FLOW REGIMES REPORT | ● | ● | ● | ● | | | | | | ● | ● | |
| 7. AQUATIC IMPACT ASSESSMENT | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| 8. FLOW NEGOTIATIONS | ● | | ● | | | | | | | | ● | |
| 9. FERC HEARINGS PREPARATION | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| 10. MITIGATION AND ENHANCEMENT PLANNING | ● | ● | | | | | | | | | ● | ● |
| 11. COMPREHENSIVE FISHERIES RESOURCES REPORT | ● | ● | | ● | ● | | | | | | ● | ● |
| 12. MIDDLE RIVER MAINSTEM HABITAT ANALYSIS | ● | ● | | ● | | | | | | | ● | |
| 13A. MIDDLE RIVER SPAWNING SURVEYS | ● | | | | | | | | | | ● | ● |
| 13B. LOWER RIVER SPAWNING SURVEYS | ● | | | | | | | | | | ● | ● |
| 14. LOWER RIVER RESIDENT AND JUVENILE FISH STUDY | ● | ● | ● | | | | | | | | ● | ● |
| 15A. LOWER RIVER SALMON ESCAPEMENT | ● | | | | | | | | | | ● | ● |
| 15B. MIDDLE RIVER SALMON ESCAPEMENT | ● | | | | | | | | | | ● | ● |
| 16A. JUVENILE OUTMIGRANTS FROM MIDDLE RIVER | ● | ● | ● | | | | | | | | ● | ● |
| 16B. JUVENILE OUTMIGRANTS FROM LOWER RIVER | ● | ● | ● | | | | | | | | ● | ● |
| 17. STREAMFLOW AND FLOOD FREQUENCY STUDIES | ● | ● | | ● | | | | | | ● | | |
| 18. SUSPENDED SEDIMENT/ TURBIDITY STUDIES | | ● | | ● | | | | | | | ● | |
| 19. HYDRO-METEROLOGICAL DATA COLLECTION | ● | ● | ● | | | | | | | | ● | ● |
| 20. LOAD FOLLOWING ALTERNATIVE | ● | | | ● | | | | | | | ● | |
| 21. LOWER RIVER MORPHOLOGIC ASSESSMENT | ● | | | ● | | | | | | | | |
| 22. MIDDLE RIVER HABITAT | ● | | | ● | | | | | | | | |


1. COMMENTS ON DEIS AND FEIS
2. WORKSHOPS / SETTLEMENT PROCESS
3. COORDINATION OF AQUATIC PROGRAM ACTIVITIES
4A. INSTREAM FLOW RELATIONSHIPS STUDIES
4B. FLOW RELATIONSHIPS COMPOSITING
5A. ECONOMIC AND ENVIRONMENTAL COMPARISONS
5B. POWER ANALYSIS
6. RECOMMENDED FLOW REGIMES REPORT
7. AQUATIC IMPACT ASSESSMENT
8. FLOW NEGOTIATIONS
9. FERC HEARINGS PREPARATION
10. MITIGATION AND ENHANCEMENT PLANNING
11. COMPREHENSIVE FISHERIES RESOURCES REPORT
12. MIDDLE RIVER MAINSTEM HABITAT ANALYSIS
13A. MIDDLE RIVER SPAWNING SURVEYS
13B. LOWER RIVER SPAWNING SURVEYS
14. LOWER RIVER RESIDENT AND JUVENILE FISH STUDY
15A. LOWER RIVER SALMON ESCAPEMENT
15B. MIDDLE RIVER SALMON ESCAPEMENT
16A. JUVENILE OUTMIGRANTS FROM MIDDLE RIVER
16B. JUVENILE OUTMIGRANTS FROM LOWER RIVER
17. STREAMFLOW AND FLOOD FREQUENCY STUDIES
18. SUSPENDED SEDIMENT/ TURBIDITY STUDIES
19. HYDRO-METEROLOGICAL DATA COLLECTION
20. LOAD FOLLOWING ALTERNATIVE
21. LOWER RIVER MORPHOLOGIC ASSESSMENT
22. MIDDLE RIVER HABITIAT SURFACE AREAS
23. LOWER RIVER ICE STUDY
24. LOWER RIVER AGGRADATION
25. FISH FOOD AVAILABILITY STUDIES
26. REPORT OF INCUBATION STUDIES
27. MIDDLE RIVER ESCAPEMENT AT TALKEETNA
28. LOWER RIVER TRIBUTARY ACCESS
29. MIDDLE RIVER MAINSTEM SPAWNING HABITAT RELATIONSHIPS
30. SLOUGH GROUND - WATER STUDY
31. LONG-TERM MONITORING PLAN
32. LOWER SUSITNA STREAM TEMPERATURE ANALYSIS
33. SALMON STREAM - LIFE STUDY
34. WINTER RESIDENT AND JUVENILE ANADROMOUS STUDIES
35. REFINEMENT OF ACCESS CRITERIA
36. LOWER RIVER REARING HABITAT IFG STUDIES
37. PRELIMINARY MITIGATION STUDIES
38. CONSTRUCTION IMPACT ASSESSMENT
39. CONSTRUCTION IMPACT MITIGATION
40. IMPOUNDMENT RESIDENT FISH MITIGATION
41. WATER QUALITY MONITORING-TSUSENA AND DEADMAN CREEKS
42. ALTERNATIVE ESCAPEMENT MONITORING METHOD
43. GLACIER STUDIES
44. REFINEMENT OF TEMPERATURE CRITERIA
47. MIDDLE RIVER TRIBUTARY STABILITY
51. HEAVY METAL LEACHING POTENTIAL
52. FISH TISSUE MERCURY CONCENTRATIONS

# SUSITNA HYDRO AQUATIC STUDIES
# PHASE II BASIC DATA REPORT

## Volume 4: Aquatic Habitat and Instream Flow Studies, 1982.

## Parts I and II

-by-

ALASKA DEPARTMENT OF FISH AND GAME
Susitna Hydro Aquatic Studies
2207 Spenard Road
Anchorage, Alaska 99503
1983

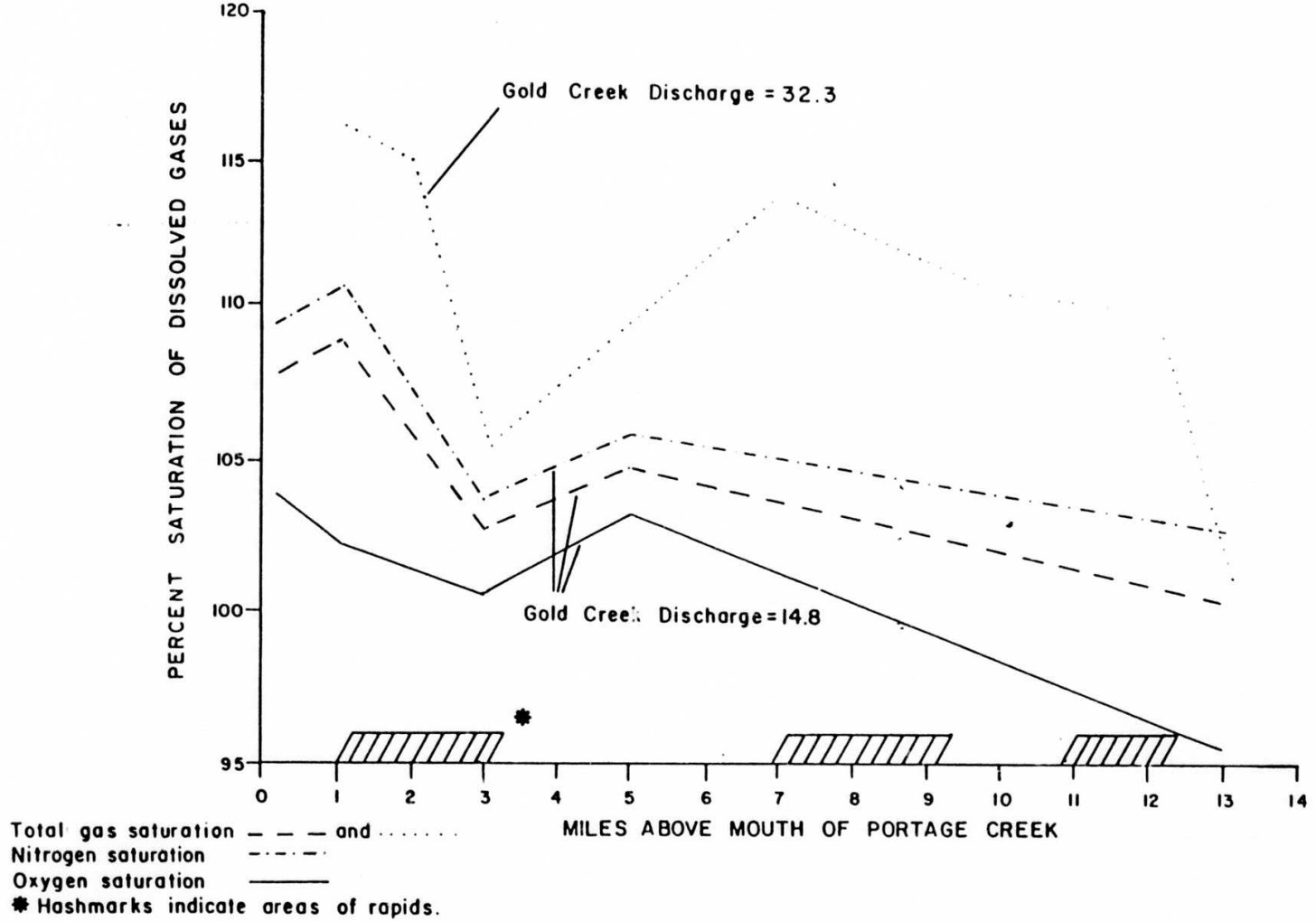



Figure 4I-3-55. Concentrations of dissolved gases in Devil Canyon rapids complex.

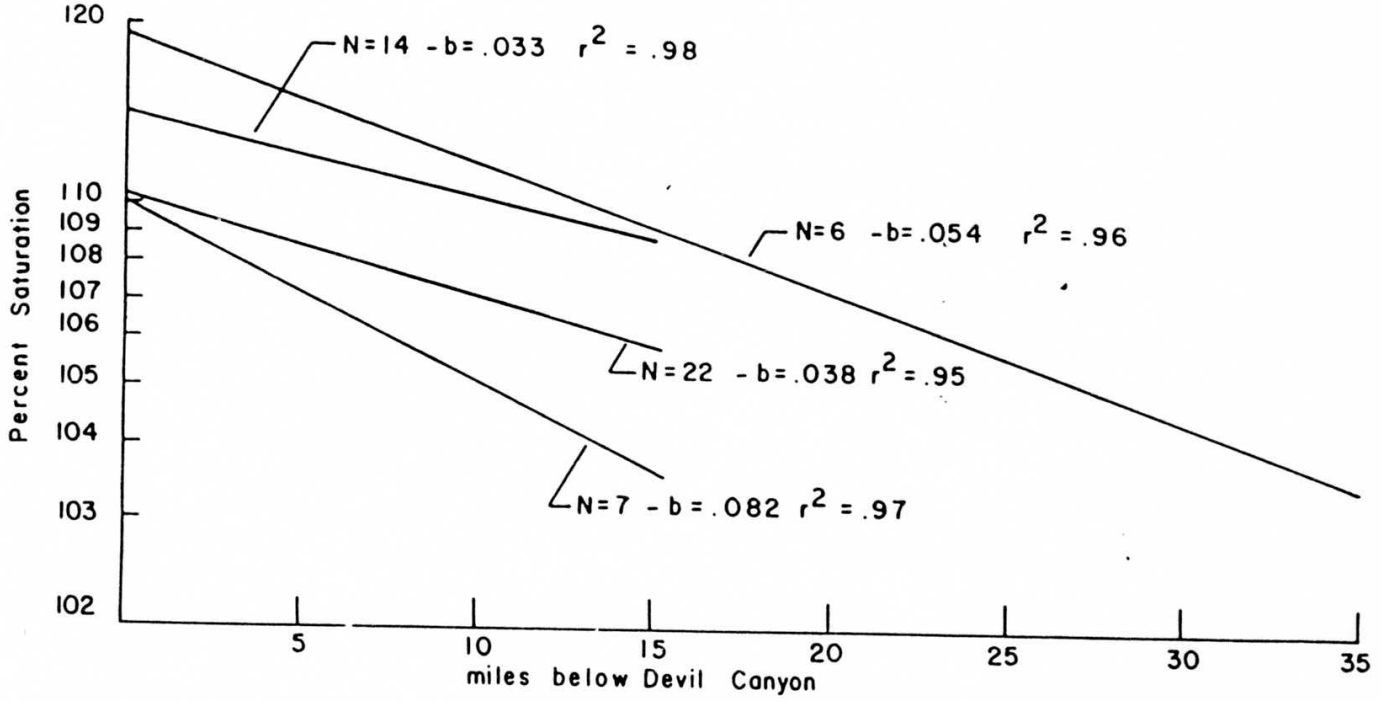



Figure 4I-3-54. Percent concentration of total dissolved gas versus distance below the Devil Canyon proposed dam site.

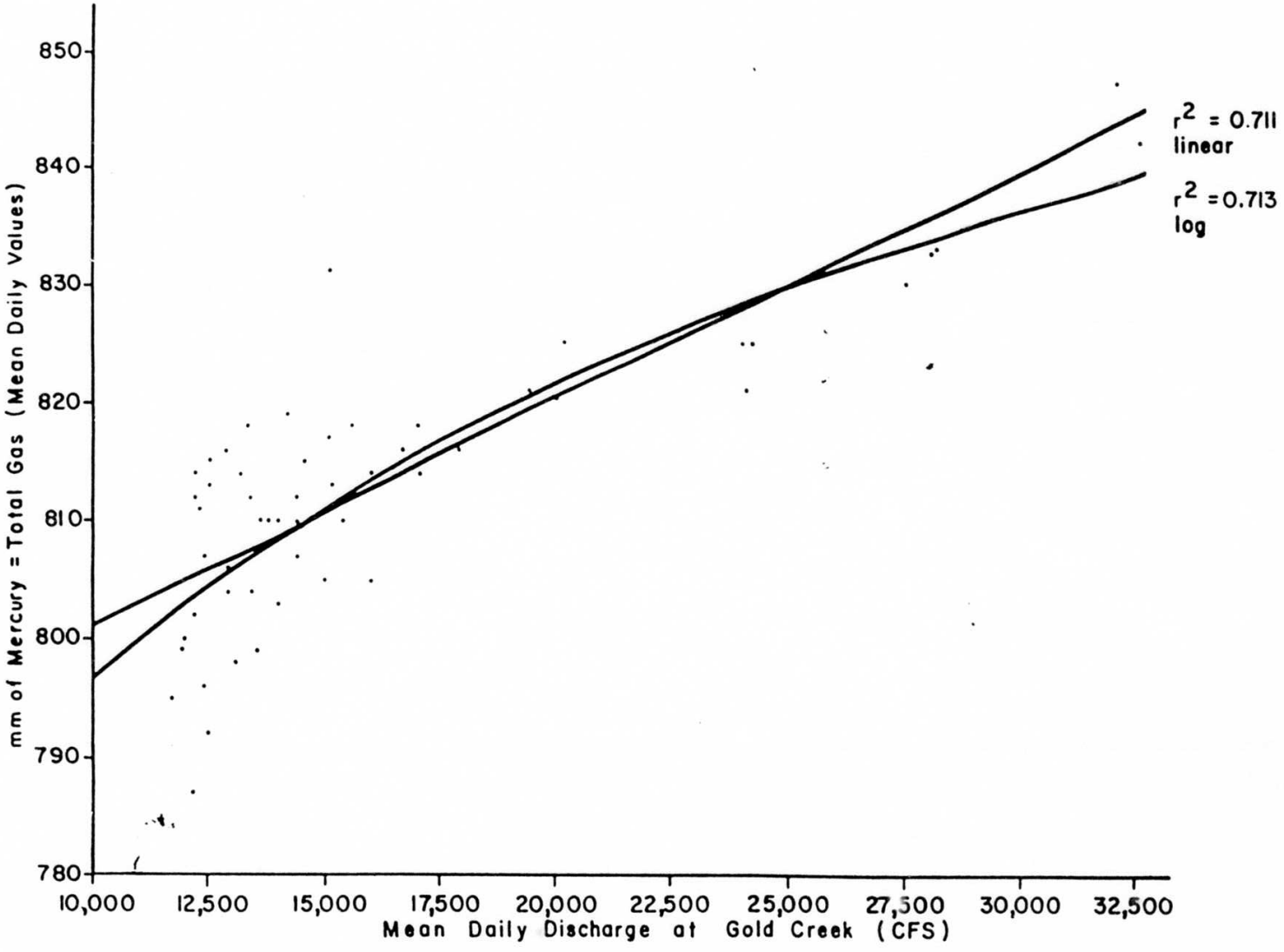
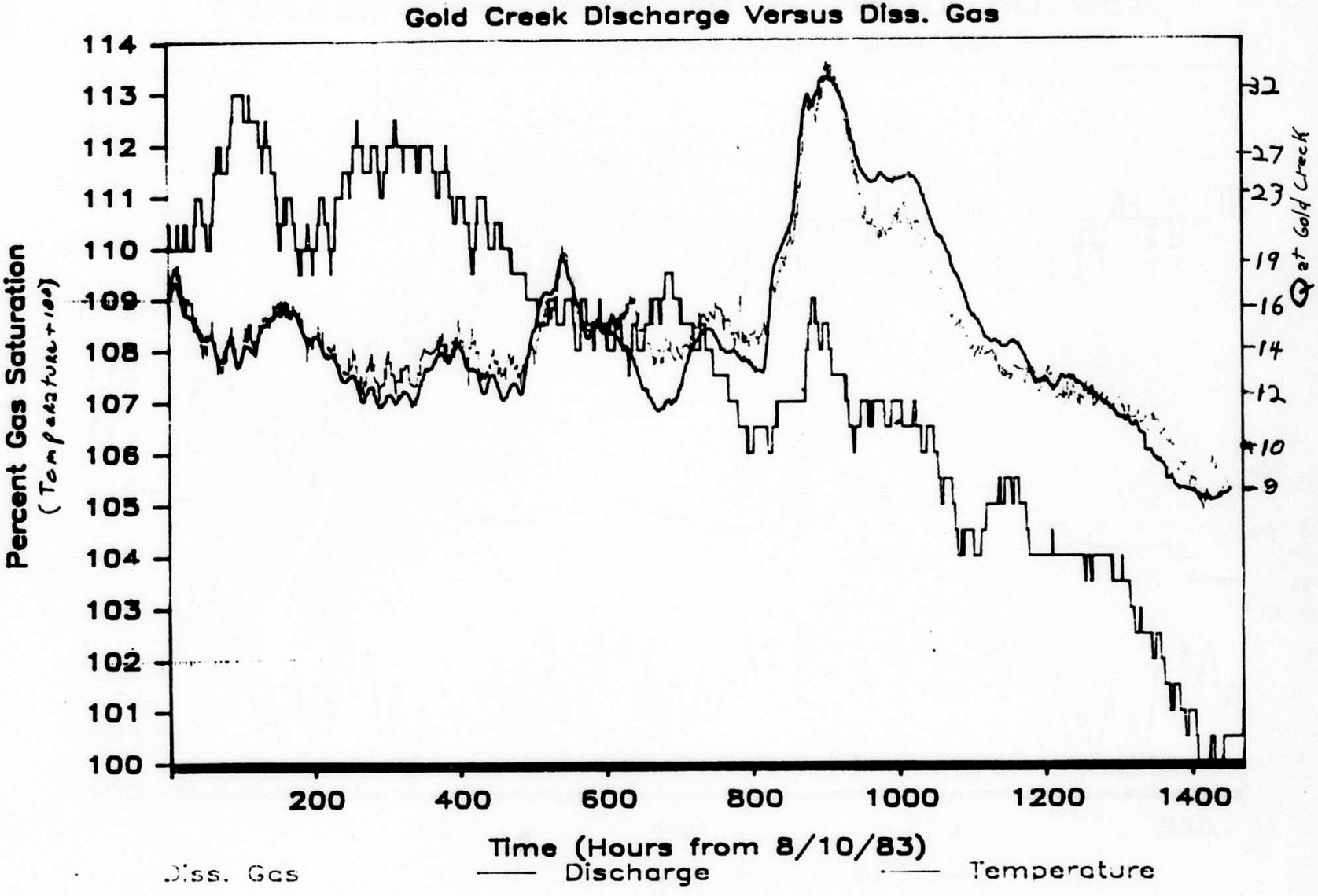



Figure 4I-3-56. Mean daily discharge versus saturometer readings below Devil Canyon.

# Dissolved Gas below Devil Canyon



# Dissolved Gas near Gold Creek