GEOTECHNICAL RESOURCES, INC.
CONSULTING ENGINEERS AND GEOLOGISTS

November 20, 1986 J\TRIAXIAL.178

Sergent, Hauskins, & Beckwith
Consulting Engineers
4030 South 500 West
Suite 90
Salt Lake City, UT 84123

Attention: Mr. Darrel Buffington

**SUBJECT: TRIAXIAL PERMEABILITY TESTING**

Dear Mr. Buffington:

At your request, Geotechnical Resources, Inc. (GRI) has completed a series of triaxial permeability tests on Shelby tube samples from your project No. E86-2030. Atterberg limits and a grain-size analysis were also performed on sample S-1, Zone 1. Table 1 contains a summary of test results. A discussion of test procedures is presented below.

The test specimens were extruded from the tubes, encapsulated in a protective rubber membrane, and mounted directly into the triaxial cells. Samples were simultaneously saturated and consolidated under the test-effective confining pressure and back pressure. Effective confining pressures were established at values which reduced the tendency of the samples to swell; back pressures were established at values necessary to achieve timely and complete saturation. The rate of flow into and out of the samples was monitored under a constant hydraulic gradient until steady state flow conditions were approached. The time required to approach equilibrium varied from 1 to 10 days, depending on sample length, permeability, swell potential, and other variables.

Specific test data for each sample is presented in Table 1. The grain size distribution for the material passing the No. 10 sieve for sample S-1, Zone 1, is presented in Figure 1, together with Atterberg limits.



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If you have any questions regarding our testing program, please do not hesitate to contact us.

Respectfully submitted for,

**GEOTECHNICAL RESOURCES, INC.**

David D. Driscoll

David D. Driscoll, P.E.
Principal

Enclosures: Table 1 - Guidelines for Classification of Soils
Figure 1 - Grain-size Analysis and Atterberg Limits

## TABLE 1 - PERMEABILITY TEST RESULTS

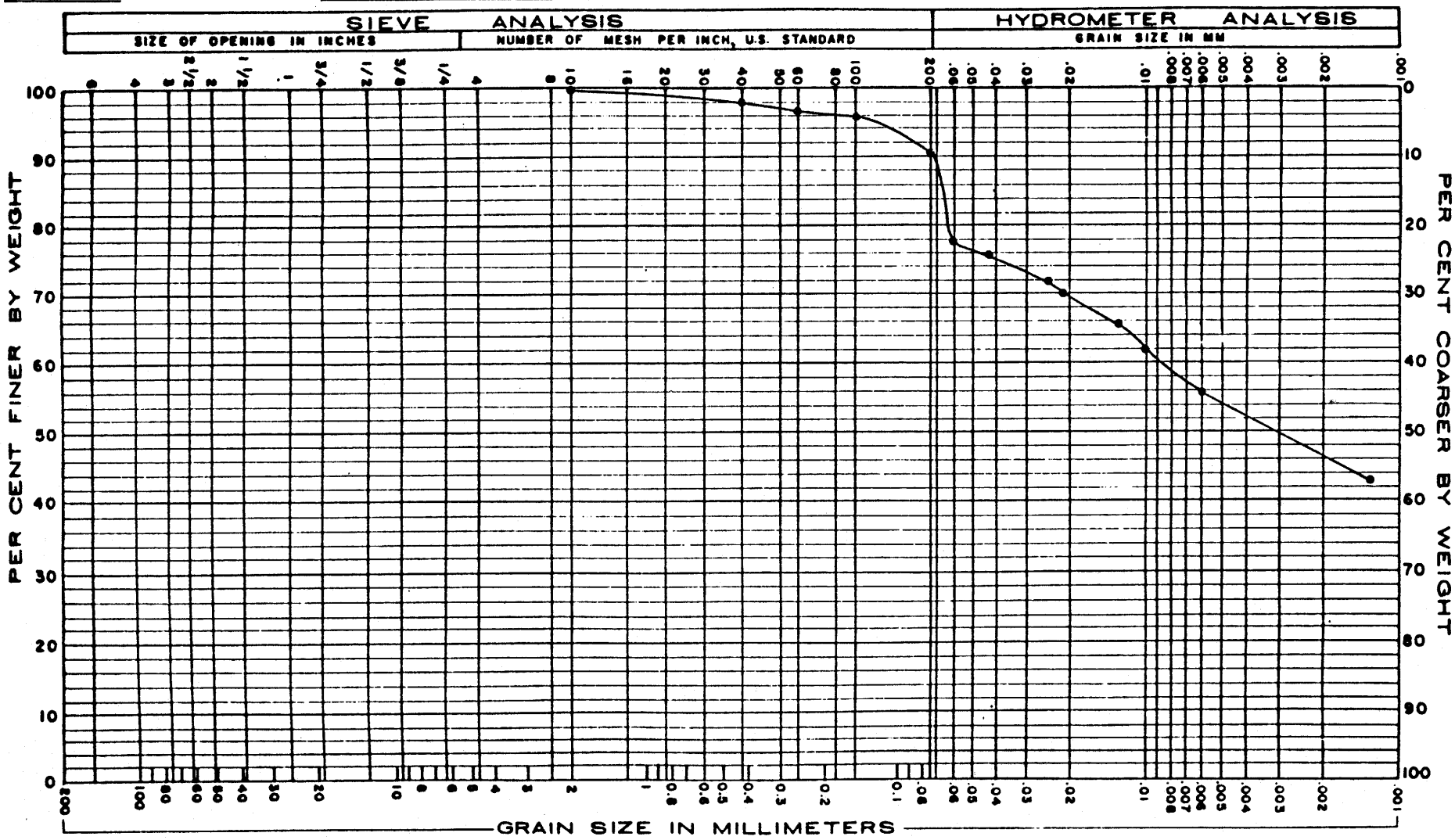
| Zone | Sample No. | Dry Wt. initial (pcf) | Moisture Content initial (%) | Moisture Content final (%) | $\sigma_c$ (psi) | $u_{bb}$ (psi) | i | k (cm/sec) | Description/Remarks |
|---|---|---|---|---|---|---|---|---|---|
| I | S-1 | 96 | 20 | 25 | 91.4 | 81.5 | 12.9 | $5.5 \times 10^{-9} \leq k \leq 8.2 \times 10^{-9}$ | Very stiff, brown, silty clay with trace fine gravel |
| I | S-2 | 101 | 21 | --- | 114.3 | 99.7 | 9.1 | $9.9 \times 10^{-9} \leq k \leq 1.5 \times 10^{-8}$ | Very stiff, brown, silty clay with scattered fine gravel |
| I | S-3 | 97 | 20 | 25 | 113.7 | 99.1 | 5.1 | $1.5 \times 10^{-9} \leq k \leq 4.8 \times 10^{-9}$ | Very stiff, brown, silty clay with trace fine gravel |
| II | S-1 | --- | 16 | --- | --- | --- | --- | --- | Inadequate sample recovery to run permeability test |
| II | S-2 | 100 | 22 | 23 | 113.3 | 98.8 | 5.1 | $1.2 \times 10^{-8} \leq k \leq 2.3 \times 10^{-8}$ | Very stiff, brown, silty clay with some coarse gravel |
| II | S-3 | 108 | 18 | 20 | 113.5 | 99.0 | 5.2 | $8.5 \times 10^{-9} \leq k \leq 2.6 \times 10^{-8}$ | Very stiff, brown, silty clay with some coarse gravel |
| III | S-1 | 108 | 19 | 22 | 113.8 | 99.2 | 10.2 | $5.4 \times 10^{-8} \leq k \leq 1.3 \times 10^{-7}$ | Very stiff, brown, silty clay with some coarse gravel |
| III | S-2 | 107 | 19 | 20 | 114.4 | 99.5 | 7.9 | $k = 6.2 \times 10^{-9}$ | Very stiff, brown, silty clay with some coarse gravel. Void filled on one side of sample. |
| III | S-3 | --- | 17 | 23 | 114.3 | 99.6 | 8.6 | $1.3 \times 10^{-8} \leq k \leq 5.4 \times 10^{-8}$ | Very stiff, brown, silty clay with trace fine gravel. Void on one side of sample. |

# GRAIN SIZE ANALYSIS

**ATTERBERG LIMITS**
$W_P$ = 20 %
$W_L$ = 42 %
PI = 22 %

Sample S-1, Zone 1 (Material passing No. 10 seive)

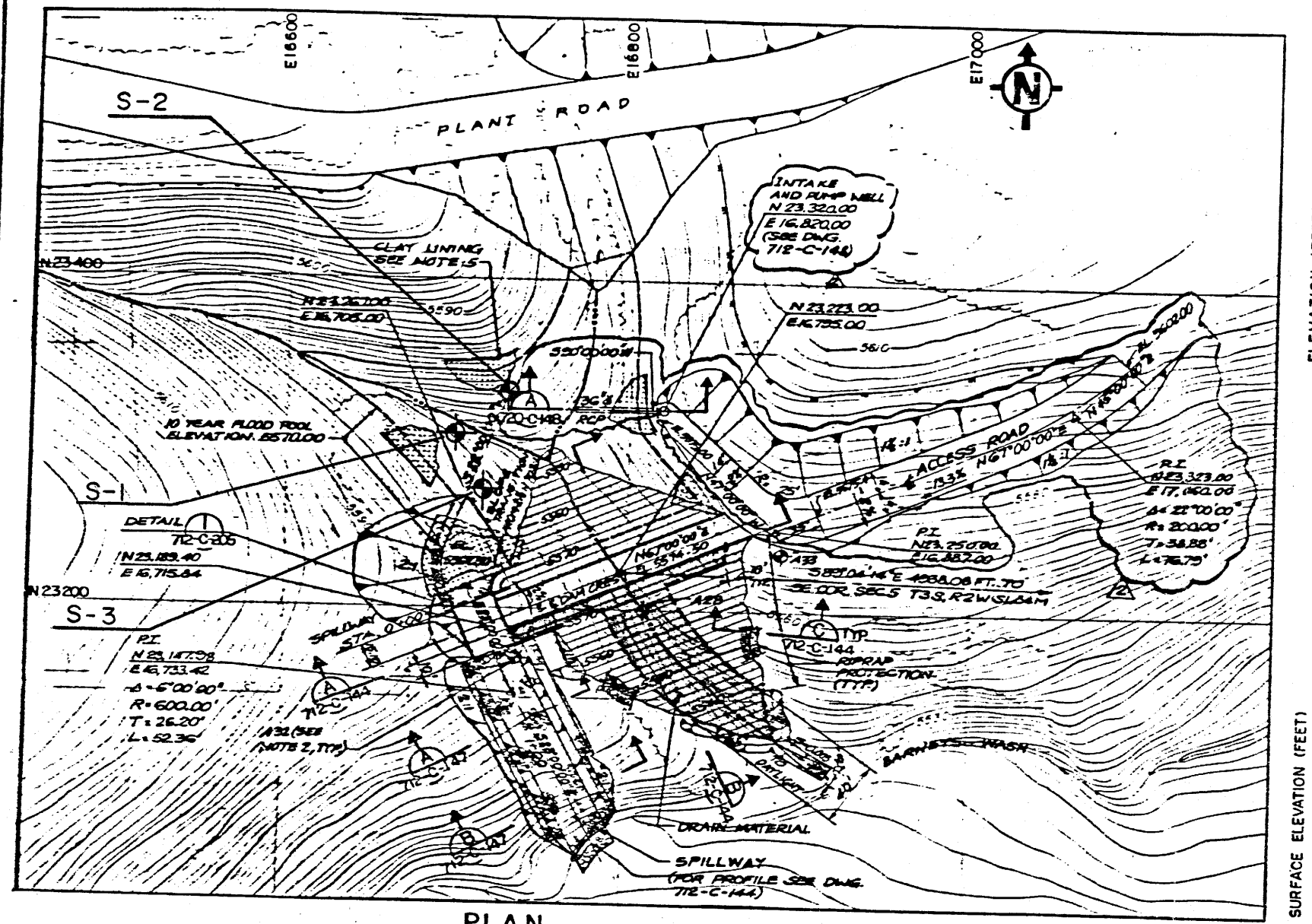
Brown clay with trace 1/2-in.-minus, subrounded gravel




| COBBLES | GRAVEL | | SAND | | | FINES |
|---|---|---|---|---|---|---|
| | COARSE | FINE | COARSE | MEDIUM | FINE | |

UNIFIED SOIL CLASSIFICATION

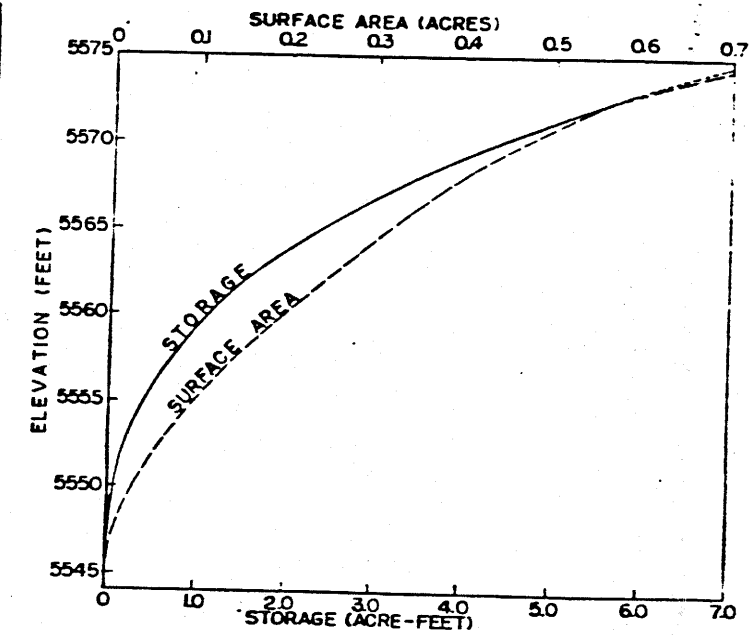
FIGURE 1



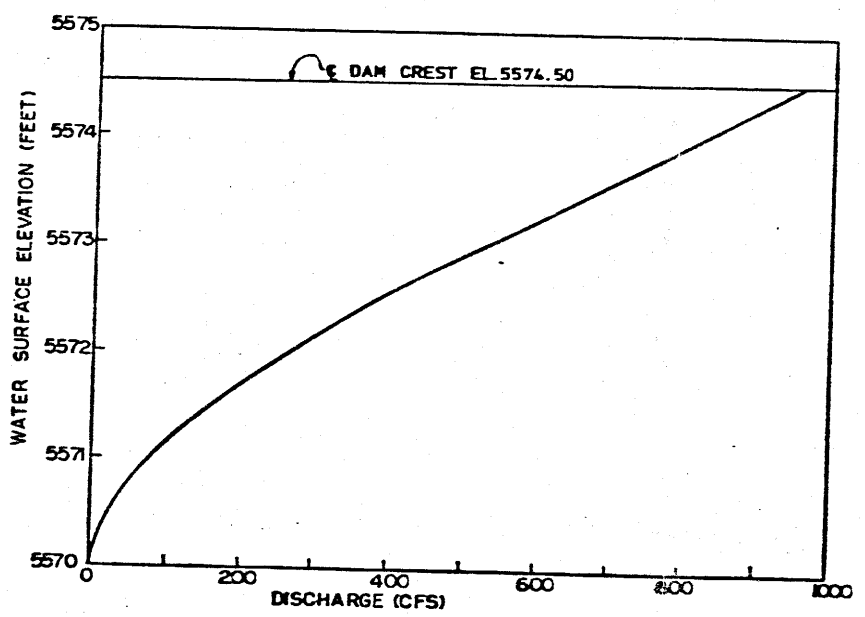

## PLAN

1"=40'

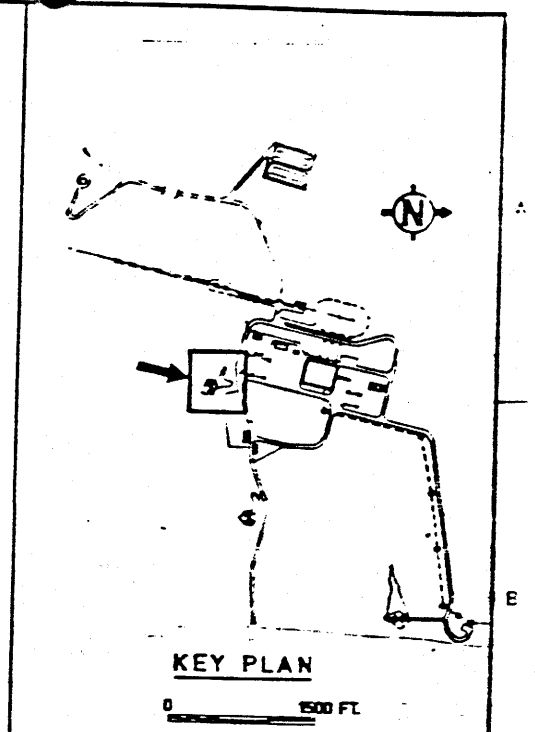
GRAPHIC SCALE 0 — 100 FT




AREA-CAPACITY CURVE




SPILLWAY RATING




KEY PLAN

## DESIGN DATA

RETENTION PONDS ARE DESIGNED TO CONTAIN A 10-YEAR 24-HOUR STORM WITH ZERO DISCHARGE. THE SPILLWAYS ARE SIZED TO PASS THE FLOW OF ½ OF THE PROBABLE MAXIMUM FLOOD (PMF). THE SPILLWAY CHANNEL LINING WILL PASS THE 100-YEAR FLOOD WITHOUT SIGNIFICANT DAMAGE AND THE ½ PMF WITHOUT DAMAGE TO THE DAM EMBANKMENT OR THE SPILLWAY STRUCTURE.

| RETENTION POND | HYDROLOGY | | | | SPILLWAY | |
|---|---|---|---|---|---|---|
| | DRAINAGE AREA (ACRES) | 24 HR RAINFALL (INCHES) | RUNOFF VOLUME (ACRE-FEET) | *RETENTION POND VOLUME (ACRE-FEET) | FLOOD EVENT 100 YR (CFS) | FLOOD EVENT ½ PMF (CFS) |
| ZONE I | 26.1 | 2.6 | 3.2 | 3.5 | 51 | 380 |
| ZONE II | 12.8 | 2.6 | 2.2 | 2.4 | 36 | 205 |
| ZONE III | 73.4 | 2.6 | 8.7 | 9.6** | 141 | 835 |

* MINIMUM VOLUME RETAINED BELOW DAM SPILLWAY CREST ELEVATION. INCLUDES 10 PERCENT OF RUNOFF VOLUME ADDED FOR SEDIMENTATION ALLOWANCE.

** EXCLUDES 7.0 ACRE-FEET OF STORAGE FOR EMERGENCY DUMP OF FLOTATION FEED PIPELINE.

✦ Location of Clay Liner Permeability Sample

## NOTES

1. RETENTION POND AND SPILLWAY MATERIALS AND CONSTRUCTION SHALL BE IN ACCORDANCE WITH SPECIFICATION NO. 17594-GC-026.
2. FOR LOCATION OF BOREHOLES SEE DWG. 712-C-113.
3. GEOTEXTILE FILTER FABRIC UNDERLYING THE GRAVEL BEDDING OF SPILLWAY CHANNEL'S RIPRAP LINING SHALL BE OMITTED WHERE SPILLWAY CHANNEL SLOPES ARE 50 PERCENT & GREATER.
4. GRID SHOWN IS THE "DISTRICT COORDINATE SYSTEM". DISTRICT NORTH IS ROTATED 0°26'46" TO THE WEST OF THE UTAH STATE PLANE COORDINATE SYSTEM. VERTICAL ELEVATIONS SHOWN ARE BASED ON THE "DISTRICT SYSTEM" DATUM WHICH IS 3.83 FEET BELOW THE USGS NORTH AMERICAN DATUM OF 1929.
5. THE ENTIRE POND BASIN AREA EXCLUDING DAM EMBANKMENT FACE SHALL BE LINED WITH A MIN. THICKNESS OF 12" OF CLAY IN ACCORDANCE WITH SPECIFICATION 17594-GC-026. THE CLAY LINING SHALL EXTEND AT LEAST UP TO WITHIN 2 FEET OF DAM CREST ELEVATION.

FILE COPY

| NO. | DATE | REVISION | APP. | APP. | REFERENCE DRAWINGS | NUMBER |
|---|---|---|---|---|---|---|
| 3 | 11-4-86 | ADDED INTAKE WELL & ACCESS ROAD | | | ZONE I RETENTION POND - PLAN | 712-C-142 |
| 2 | 5-6-86 | ADDED CLAY LINING | | | ZONE II RETENTION POND - PLAN | 712-C-143 |
| 1 | 4-8-86 | ISSUED FOR CONSTRUCTION | | | ZONE I RETENTION POND - SECTIONS | 712-C-144 |
| 0 | 3-21-86 | ISSUED FOR BID | | | ZONE II RETENTION POND - SECTIONS | 712-C-145 |
| A | 3-11-86 | ISSUED FOR APPROVAL | | | RETENTION PONDS - PROFILE & SECTIONS | 712-C-147 |
| | | | | | ZONES I & II SPILLWAYS - PLAN, SECTIONS & DETS. | 712-C-205 |
| | | | | | ZONE II SPILLWAY - PLAN, SECTIONS & DETS. | 712-C-206 |

QUANTITY TRACKING*

| | |
|---|---|
| EXCAVATION | 17,265 CU. YD. |
| FILL | 35,870 CU. YD. |
| RIPRAP | 3,270 CU. YD. |
| DRAIN MATERIAL | 3,260 CU. YD. |

*TOTAL QUANTITIES FOR DWG. 712-C-141 THRU 147 (QUANTITIES ARE FOR TRACKING PURPOSES ONLY.)

NOTES

DESCRIPTION | COST ACCOUNT

BECHTEL CIVIL & MINERALS, INC.
SAN FRANCISCO

| APPROVAL | DATE |
|---|---|
| Rev 2 | 11-5-86 |
| Rev 1 | 5-8-86 |
| KENNECOTT | |
| PROJECT ENGINEER | 4-23-86 |
| PROJECT DIRECTOR | |

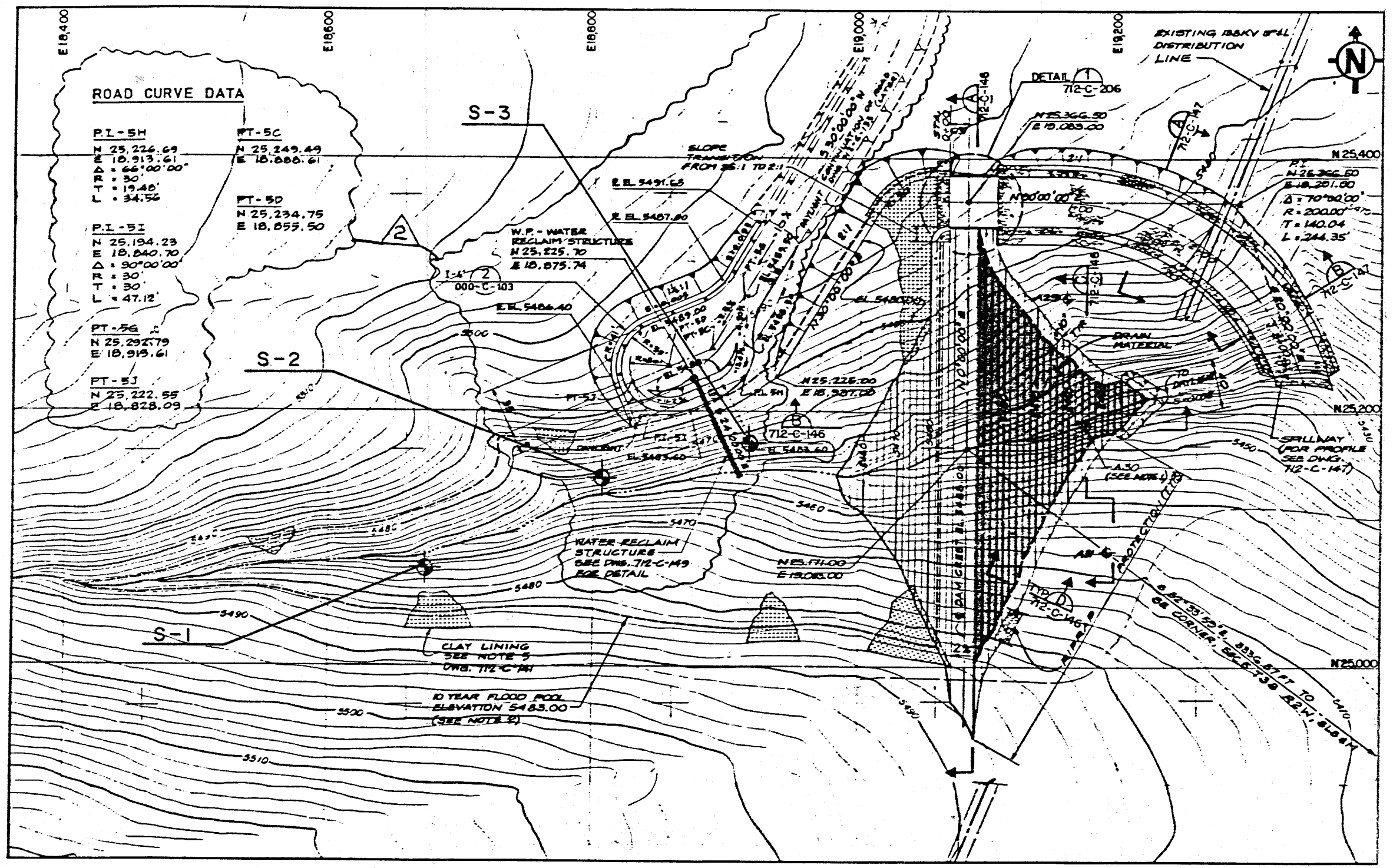
SCALE AS NOTED DATE

DRAWN MMK · MS · JW 3-25-86
CHECKED T. NERAY 3-25-86
DESIGNED MMK 3-25-86

KENNECOTT

UCD CONCENTRATOR MODERNIZATION
CONCENTRATOR SITE
ZONE I RETENTION POND
PLAN

Job No. 17594 | Dwg. No. 712-C-141 | 2

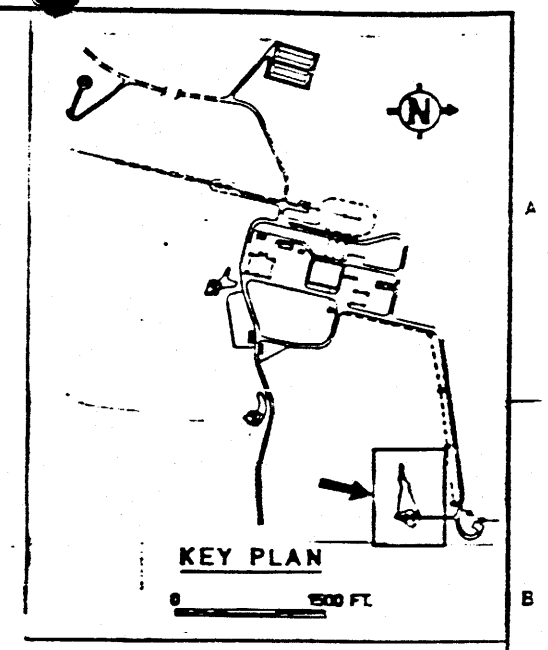


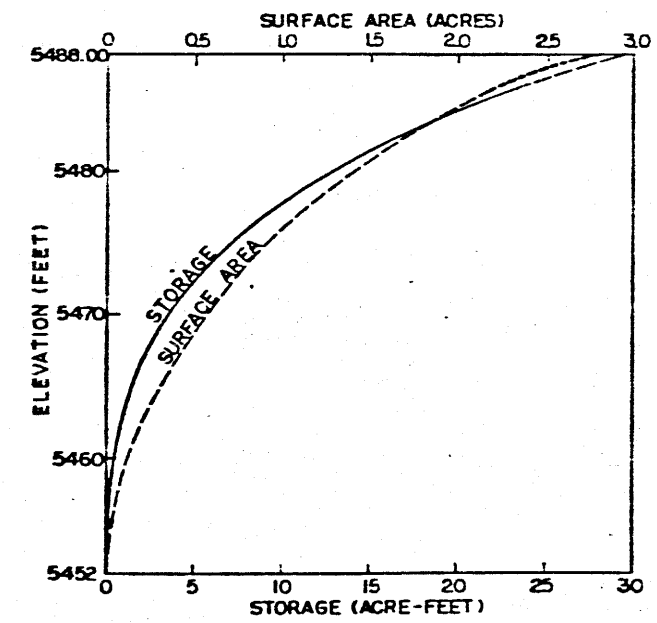

PLAN

1"=40'

0 100 FT

GRAPHIC SCALE




AREA - CAPACITY CURVE

Location of Clay Liner Permeability Sample

FILE COPY

| NO | DATE | REVISION | APP | APP |
|---|---|---|---|---|
| 2 | 8-5-86 | ADDED WATER RECLAIM STRUCTURE & BENCH | | RCV |
| 1 | 5-1-86 | ADDED CLAY LINING | | RCV |
| C | 11-8-84 | ISSUED FOR CONSTRUCTION | | RCV |
| B | 8-21-84 | ISSUED FOR BID | | RCV |
| A | 3-8-84 | ISSUED FOR APPROVAL | | RCV |

REFERENCE DRAWINGS | NUMBER

1. FOR GENERAL NOTES AND REFERENCE DRAWINGS SEE DWG. 712-C-141.
2. 10 YEAR FLOOD POOL ELEVATION SHOWN IS SUPERIMPOSED ON TOP OF 7 ACRE-FT OF STORAGE ALLOWANCE FOR EMERGENCY DUMP OF FLOTATION FEED PIPELINE.

NOTES

DESCRIPTION | COST ACCOUNT

BECHTEL CIVIL & MINERALS, INC.
SAN FRANCISCO

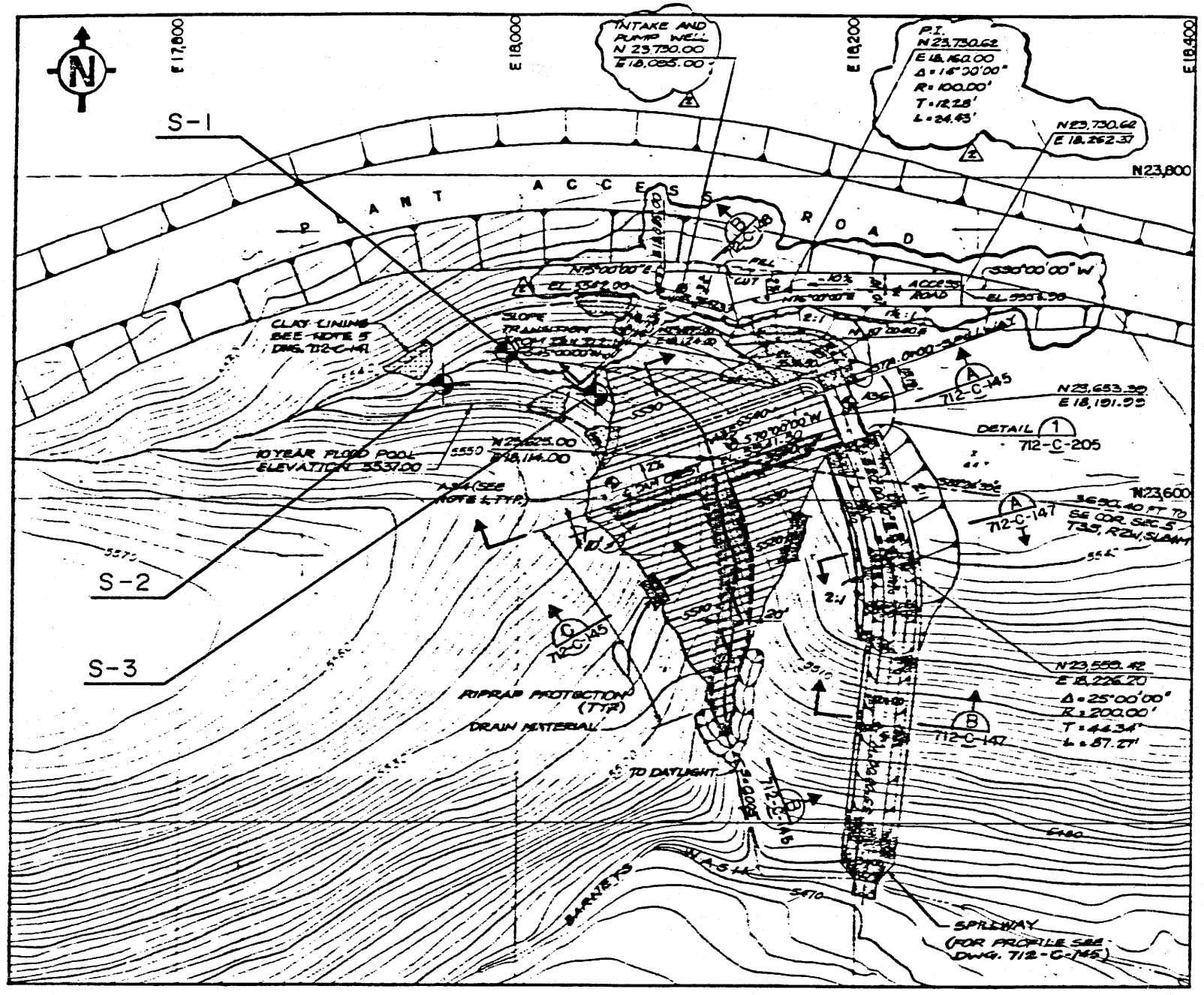
| APPROVAL | DATE |
|---|---|
| Rev 2 RCV | 8-5-86 |
| Rev 1 RCV | 5-1-86 |
| KENNECOTT | |
| PROJECT ENGINEER RDJ | 4-29-86 |
| PROJECT DIRECTOR | |

| SCALE AS NOTED | DATE |
|---|---|
| DESIGNED BY MMK-MS-JW | 3-25-84 |
| DRAWN BY T. NERAY | 3/29/84 |
| CHECKED BY MMK | 3-30-84 |
| APPROVED BY | 4/10/84 |
| APPROVED BY | |

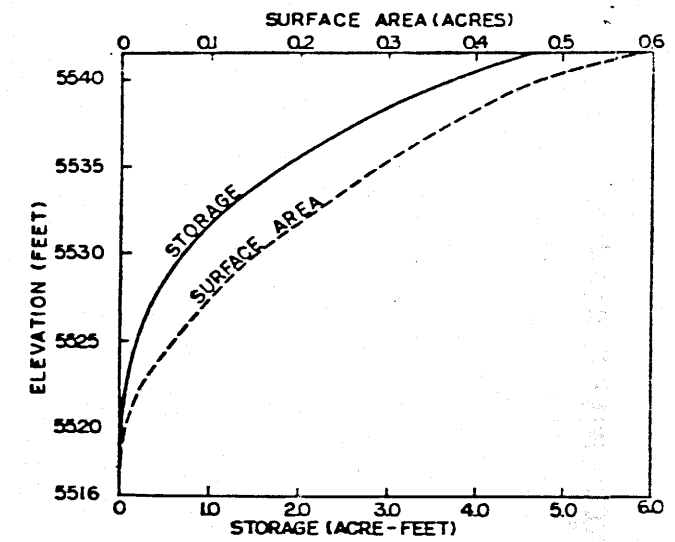
KENNECOTT

UCD CONCENTRATOR MODERNIZATION
CONCENTRATOR SITE
ZONE III RETENTION POND
PLAN

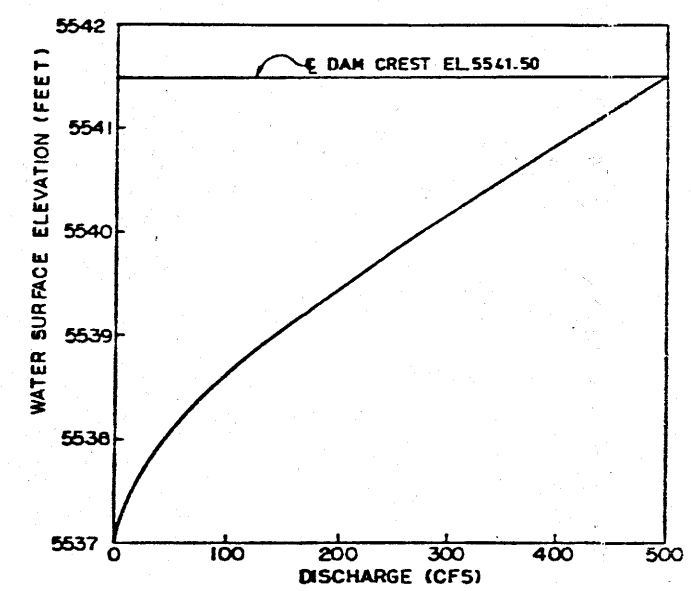
Job No. 17594 | Dwg. No. 712-C-143 | 2



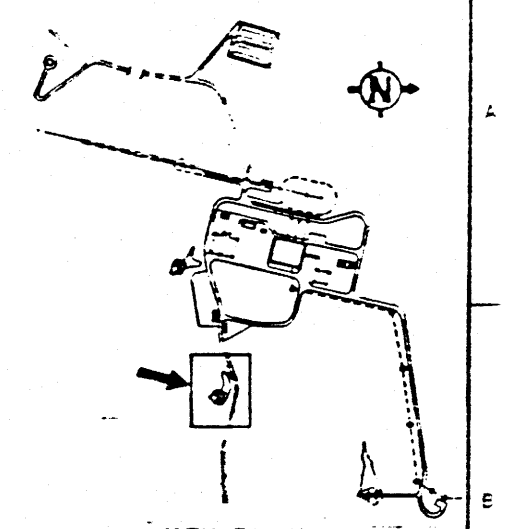

PLAN
1"=40'
0 100 FT
GRAPHIC SCALE




AREA - CAPACITY CURVE




SPILLWAY RATING




KEY PLAN

NOTES:

1. FOR GENERAL NOTES AND REFERENCE DRAWINGS SEE DWG. 712-C-141.

Location of Clay Liner Permeability Sample

FILE COPY

| NO | DATE | REVISION | APP | APP | REFERENCE DRAWINGS | NUMBER |
|---|---|---|---|---|---|---|
| 2 | 8-4-86 | ADDED INTAKE WELL & ACCESS ROAD | | | | |
| 1 | 7-2-86 | ADDED CLAY LINING | | | | |
| 0 | 4-28-86 | ISSUED FOR CONSTRUCTION | | | | |
| B | 3-27-86 | ISSUED FOR BID | | | | |
| A | 3-4-86 | ISSUED FOR APPROVAL | | | | |

NOTES

DESCRIPTION | COST ACCOUNT

BECHTEL CIVIL & MINERALS, INC.
SAN FRANCISCO

| APPROVAL | | DATE |
|---|---|---|
| Rev 2 | RCF | 8-5-86 |
| Rev 1 | RDT | 4-4-86 |
| KENNECOTT | | |
| PROJECT MANAGER | RDJ | 4-23-86 |
| PROJECT DIRECTOR | | |

SCALE AS NOTED

| | | DATE |
|---|---|---|
| DRAWN BY | MMK-MS-JW | 3-25-86 |
| DESIGNED BY | T. NERAY | 3-25-86 |
| CHECKED BY | MMK | 3-25-86 |
| APPROVED BY | | 4/17/86 |

KENNECOTT

UCD CONCENTRATOR MODERNIZATION
CONCENTRATOR SITE
ZONE I RETENTION POND
PLAN

Job No. 17594 | Dwg. No. 712-C-142 | 2