# FINAL DESIGN REPORT
# AND DESIGN CALCULATIONS
# HARQUAHALA VALLEY WPP, ARIZONA
# HARQUAHALA FRS
# AUGUST 1980

A334.601

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
AUGUST 8, 1980

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# FINAL DESIGN REPORT

## SUMMARY:

The design computations, construction drawings and specifications are complete. The drawings and specifications are being submitted to Water and Power Resource Service for inclusion in their contract for the Granite Reef Aqueduct Reach 5B. Changes to meet their format and specifications are anticipated. A joint review and approval of the final drawings and specifications will be required.

## DESCRIPTION OF JOB:

The job consists of approximately 11.8 miles of earth embankment, a principal spillway consisting of a standard open top riser in the reservoir, a 48-inch diameter reinforced concrete pipe conduit, and a SAF outlet as an energy dissipator. The emergency spillway is a 150-foot wide reinforced concrete chute with baffle blocks and will discharge into the aqueduct.

## BASIS FOR DESIGN:

In addition to SCS standards and criteria, the following references were used as a basis for design:

1. National Cooperative Highway Research Program Report 108, Tentative Design Procedure for Riprap-Lined Channels, High Research Board, National Research Council, National Academy of Sciences - National Academy of Engineering, 1970.

2. Civil Engineering Handbook, Leonard Church Urquhart, Fourth Edition, McGraw-Hill Book Company, Inc., 1962.

3. Handbook of Hydraulics, Horace Williams King, Fourth Edition, McGraw-Hill Book Company, Inc., 1954, 5th Edition, 1963.

4. Simplified Design of Reinforced Concrete, Second Edition, Harry Parker, M.S., John Wiley & Sons, Inc., 1962 & Third Edition, 1968.

5. Design of Small Dams, United States Department of Interior, Bureau of Reclamation, 1st and 2nd ed, 1960, 1973.

6. Reinforced Concrete Design Handbook, Working Stress Method, Third Edition, 1965, American Concrete Institute, Publication SP-3.

7. Earth Manual, U.S. Department of the Interior, Bureau of Reclamation, United States Government Printing Office, Washington, D.C., 2nd ed 1974.

8. Seepage, Drainage and Flow Nets, Harry R. Cedergren, John Wiley & Sons, Inc., New York 1967.

9. "Use of Riprap for Bank Protection" Hydraulic Engineering Circular No. 11 June 1967, U.S. Dept. of Transportation FHA BPR.

10. "ICES-Lease -1", R69-22 Soils Mechanics Publication No. 235 MIT April 1969.

11. Design Manual Concrete Pipe, American Concrete Pipe Association, 1st ed February 1970.

12. Steel Pipe Design and Installation, American Water Works Assn. Manual of Water Supply Practices, AWWA No. 11, 1964.

FOUNDATION AND EMBANKMENT DESIGN:

The recommended foundation treatment deviates from the geology report and the preliminary design in that pre-wetting will be relied upon to prevent major fracturing from foundation collapse rather than removal and reconsolidation of loose material. A cutoff trench will be excavated to explore the foundation for buried channels not covered by an adequate natural blanket. Exposed buried channels will be cut off where possible. In locations where cutoff appears improbable, foundation drainage is provided. The embankment design for Reach 1 relies on the coarseness of the material to resist cracking and routing during placement to prevent piping. Reach 2 is provided with an embankment drain. A three-foot thick blanket will be provided where upstream borrow operations expose clean gravel or sands.

The foundation of Reach 1 will be prewet to a minimum depth of twelve feet. Consolidation of the foundation is expected to occur during construction as a result of the prewetting and construction operations. The foundation will be stripped to a depth of one foot to permit inspection for unsuitable materials. Observed unsuitable material will be removed. A natural blanket thickness of five feet is required over channels of clean sand or gravel to prevent uplift at the downstream toe. The cutoff trench will be excavated to a minimum depth of five feet to check the blanket thickness. If continuous subsurface channels exist at this depth, the cutoff will be extended to cut these channels off. The log of drill holes shows two locations where apparent channels exist beyond the limits of the hole. Toe drains were designed for these locations. If the extensions of the cutoff trench are unable to reach the limits of the channel, then the contract should be modified to provide a toe drain at that location.

Embankment dracking is not anticipated in Reach 1. Dams in Maricopa County constructed of similar materials have not exhibited desiccation or movement cracks. An embankment drain will not be used in this reach. The materials will be routed in a manner to construct an impervious and stable fill. No settlement is expected.

The foundation treatment used in Reach 1 will also be used in Reach 2. It is not expected that toe drains will be required in this reach since the log of borings and test pits has not shown deep channels within this reach. However, the materials are much more susceptible to collapse than those in Reach 1. Pre-wetting to a depth of 12 feet, as required, will permit the collapse-prone material to settle with a minimum of fracturing.

An embankment drain, as provided in Reach 2, will prevent failure from the mechanism of cracking. One and one-half feet of overfill is provided to allow for foundation settlement after construction. An additional 1.3 feet of fill is added gradually from the emergency spillway to the west end of the dam to allow for movement of the freeboard hydrograph flows to the emergency spillway.

EMERGENCY SPILLWAY DESIGN:

The centerline location of the emergency spillway has been adjusted to take maximum advantage of the known location of the rock. The entire invert of the exit channel will be on sound rock. The rock beneath the structure will be graded to prevent differential settlement and since no settlement is anticipated no special joint treatment was provided where the structure foundation changes from rock to earth.

The Washington computer program from T.R. 50 was used to design the chute sidewalls, aprons, and paving slabs. Methods from National Engineering Handbook Section 11 were used for the structural design of the headwall, headwall extension, inlet side walls, and wingwall.

PRINCIPAL SPILLWAY DESIGN:

A standard open riser inlet is being used. In response to the recommendation of a covered top riser in Supplement No. 1 to Design Report, dated June 8, 1979, the open top is considered safe because of its isolated location. The only reason a covered top was ever considered in the work plan was to protect it from falling rocks. The rocky hillside is not close enough to be a problem.

A 48-inch diameter reinforced concrete pipe is being used for the principal spillway with no increase in dam height.

Since the outlet elevation is well below any prior geologic investigation, another test pit was dug near the SAF. The soil log is in the appendix. When these soils are compared to the design riprap gradation, no bedding is required.

MISCELLANEOUS APPURTENANCE DESIGN:

Two gated outlets are provided in accordance with the work plan. The ramp road crossing has been eliminated, but access ramps have been provided for maintenance. Fencing will be installed in accordance with the EIS. Provisions for livestock and wildlife to reach water and cross the dam have been made. Chain link protective fence will be provided at the principal and emergency spillways.

The Drain Outlet is located at the lowest part of the impoundment area other than the principal spillway. It consists of a slide gate to a 24-inch diameter reinforced concrete pressure pipe which carries water under the CAP Aqueduct to a submerged pipe outlet basin. The basin is sized according to Greg Cunningham's 1964 writeup. It has adequate storage below the pipe invert for the average annual sediment yield at that part of the dam. The riprap is much more extensive than Cunningham's writeup calls for. A short outlet channel guides flows from the basin to a natural channel adequate to carry the design peak runoff.

The New Tank Outlet consists of a slide gate to a 24-inch diameter reinforced concrete pipe to the left side of the CAP Aqueduct. A 24-inch diameter steel pipe carries water from there to a standard impact basin. A short outlet channel drains toward New Tank Reservoir to maintain livestock water at that location. The New Tank Watershed is relatively flat and high within our reservoir, so a small collection system will be constructed upstream from the dam. The steel pipe will be 0.375

inches thick with a coal tar-epoxy coating where buried and a polyvinyl chloride paint where exposed over the aqueduct. It will be supported at the center of the aqueduct by a 12-inch diameter concrete column similar to other aqueduct crossings constructed by the Water and Power Resource Service.

William E. Payne, Jr. — Aug. 8 1980
Submitted — Date

Susanna M. Seckbach — Aug. 8, 1980
Submitted — Date

Chief, Irrigation Design Engr — Aug 8 1980
Recommended — Date

William W. Anderson, Acting SCE — Aug 8, 1980
Approved — Date

AE
PJM
INDEX

8-7-80

Harquahala FRS – DESIGN CALCULATIONS




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FOUNDATION -
GENERAL

AC HARQUAHALA VALLEY WDP HARQUAHALA FRS
PJM 2/7/80 UAB 7/80
FOUNDATION DESIGN. 1 15

1. GEOLOGY REPORT STATEMENTS

a. PRELIMINARY GEOLOGIC INVESTIGATION p25 (FOR REACH 17)

"TWO SAMPLES OF G.P. GM (APPENDIX, P 109 & 113) CONTAINED SO LITTLE FINES THAT ONLY PERCENT RELATIVE DENSITIES WERE OBTAINABLE. THESE ARE SPECIAL CASES WHICH WILL TAKE ADDITIONAL STUDY TO DETERMINE THE ACTUAL DRY DENSITIES TO BE OBTAINED WITH STANDARD COMPACTIVE EFFORT."

"IN THIS PARTICULAR CASE, FOUNDATION PREPARATION SHOULD INCLUDE ONE FOOT OF STRIPPING. A KEY TRENCH FIVE FEET DEEP AND FIFTEEN FEET WIDE WITH 2:1 SIDE SLOPES SHOULD BE INSTALLED. IT IS ANTICIPATED THAT IF THE FILL MATERIAL (MINUS OVERSIZE) IS PLACED AT NO LESS THAN OPTIMUM MOISTURE AND ROLLED SOMEWHAT GREATER THAN STANDARD COMPACTIVE EFFORT, FOUNDATION CONSOLIDATION WILL TAKE PLACE DURING CONSTRUCTION AND THE EMBANKMENT WILL HAVE STABILIZED IT SELF

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PJM 2/7/80
FOUNDATION DESIGN

HARQUAHALA VALLEY WPP HARQUAHALA FRS

2 15

b. PRELIMINARY GEOLOGIC INVESTIGATION P29 (FOR REACH 2)

" THREE 150 TO 200 FEET LONG TRENCHES WERE EXCAVATED TO DETERMINE THE EXTENT OF THE SP FOUND ALONG REACH 2 WASHES. HOWEVER THERE WERE VERY FEW BURIED SAND LENSES OR CHANNELS, BUT LOCALIZED SMALL POCKETS OF UP TO 50% COBBLES WERE UNCOVERED IN THE TOP THREE FEET. THE SILTY TOPSOIL IS POORLY DEVELOPED, LOOSE AND LESS THAN ONE FOOT THICK. . . . . IN VIEW OF THESE TRENCH EXCAVATION FINDINGS, IT IS NOW RECOMMENDED THAT ALMOST THE SAME CONSTRUCTION PROCEDURES, FOUNDATION PREPARATION AND DESIGN SHOULD APPLY TO REACH 2 AS THEY DO ON REACH 1

C PRELIMINARY GEOLOGIC INVESTIGATION P 30, 31 F FOR REACH 2)

Of the several methods available to effectively compensate for this settlement, the first may be considered, although the second is favored at this time. Prewetting the foundation to ten feet and adding a surcharge would effectively concolidate the weak soil strata in this interval if a key trench similar to that recommended for Reach 1 were also installed on Reach 2. However, the more favored method of

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application solution is coincidental with visual inspection of the many backhoe test pits and test trenches.

These excavations have shown that an average 6 3/4 feet of the foundation is weak and should be removed and recompacted to provide adequate foundation for the embankment. Actual foundation excavation may vary between 4.5 and 8.0 feet as shown by short dashed lines on the Plan and Profile sheets at the test pit locations.

d PRELIMINARY GEOLOGIC INVESTIGATION P30 (FOR REACH 2)

Compaction at optimum moisture should produce maximum dry density, and oversize material will not be a factor on this reach as only a trace will be encountered. Foundation settlement should occur proportionately as fast as the load is applied, leaving a stable embankment at completion of construction.

c PRELIMINARY GEOLOGIC INVESTIGATION P33 (FOR REACH 2)

According to the test pit logs, firm and competent material was encountered at an average depth of 6 3/4', and ranged between 4.5' and 8.0' (moderately to strongly cemented and hard to very hard to excavate). ~~These soils are generally dry (slightly less than 3.5%~~

f GEOLOGIC INVESTIGATION 1978 P6 (REACH 1)

The average depth of foundation excavation is 7.0 feet, but this varies from a maximum of 15.5 feet at Station 322+25 (742+50) to a minimum of 0.5 feet in one of the caliche bottomed washes at Station 125+40 (933+50). There does not

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FOUNDATION DESIGN
4 15

appear to be any suitable material in the foundation capable of providing a base for cutoff. It is recommended that if a flow net study shows the foundation excavation line to not be deep enough, then a partial cutoff should be installed below the foundation excavation line deep enough to carry the phreatic line out downstream of the toe of dam.

g GEOLOGIC INVESTIGATION 1978
P7-8 (REACH 2)

~~soil type~~. Overall there may be more SM material present along Reach II than any other soil type. Relatively thick sequences of SM were found at Stations 683+00 382+50 (0-25.0'), 692+50 372+50 (0-23.0'), 673+00 392+50 (15.0'-33.0') 573+00 492+00 (20.5' -37.5'), 613+00 452+00 (0-16.5'), 663+00 402+50 (4.3'-20.0'), 712+00 353+00 (20.0'-35.0') and 653+00 412+50 (9.0'-22.5'). In addition, closely related soils SM-ML, SM-SC and SP-SM are fairly common. Significant thickness of SM-SC is found at Stations 603+00 462+00 (15.8'-32.5'), 593+00 482+00 (30.0' -40.0') and 653+00 412+50 (27.5'-36.5'). SP-SM soils were generally loose and weakly cemented, comprising 11 feet out of the top 20.5 feet of material at Station 573+00 492+00, and a 7.5 feet thick buried channel at Station 633+00 432+00 (6.5'-14.0'). SM-ML soils are most commonly top soils, and are known to be as much as 8.0 feet thick (Station 603+00 462+00).

h GEOLOGIC INVESTIGATION 1978
P8-9 (REACH 2)

Buried channels of sand could pose an unforeseen threat to the credibility of the foundation excavation line. The only surface wash that was excavated across to explore this possibility (TP-79 at Station 633+50 432+00) found 3.5 feet of alluvial sand in its filled but well outlined surface channel.

AZ HARQUAHALA VALLEY WPP HARQUAHALA PRJ
RJM 2/7/80
FOUNDATION DESIGN 5 15

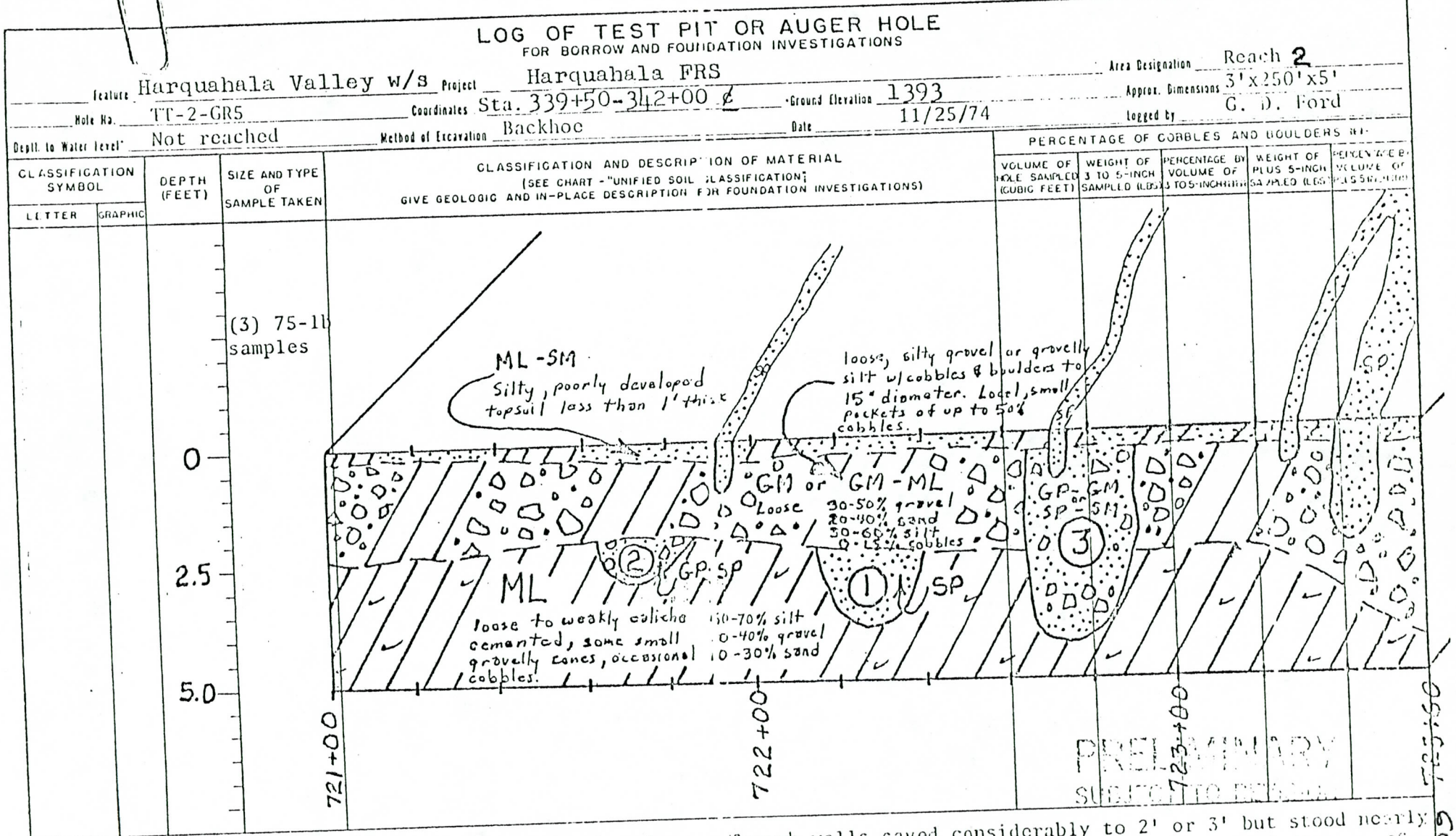
What was unexpected was the 7.5 feet of buried channel sands in the 6.5 feet to 14.0 feet interval. Although this was not anticipated, it now appears that there is good potential for finding buried channel sands all along the reach IN THE TOP 15 TO 20 FEET.

7-1330 (Combining 7-1326 and 7-1328)
(8-74) Bureau of Reclamation

# LOG OF TEST PIT OR AUGER HOLE
FOR BORROW AND FOUNDATION INVESTIGATIONS

Feature: Harquahala Valley w/s  Project: Harquahala FRS  Area Designation: Reach 2
Hole No.: TT-2-GR5  Coordinates: Sta. 339+50-342+00 ℄  Ground Elevation: 1393  Approx. Dimensions: 3'x250'x5'
Depth to Water Level: Not reached  Method of Excavation: Backhoe  Date: 11/25/74  Logged by: G. D. Ford

| CLASSIFICATION SYMBOL | | DEPTH (FEET) | SIZE AND TYPE OF SAMPLE TAKEN | CLASSIFICATION AND DESCRIPTION OF MATERIAL (SEE CHART - "UNIFIED SOIL CLASSIFICATION") GIVE GEOLOGIC AND IN-PLACE DESCRIPTION FOR FOUNDATION INVESTIGATIONS | PERCENTAGE OF COBBLES AND BOULDERS BY | | | | |
|---|---|---|---|---|---|---|---|---|---|
| LETTER | GRAPHIC | | | | VOLUME OF HOLE SAMPLED (CUBIC FEET) | WEIGHT OF 3 TO 5-INCH SAMPLED (LBS) | PERCENTAGE BY VOLUME OF 3 TO 5-INCH | WEIGHT OF PLUS 5-INCH SAMPLED (LBS) | PERCENTAGE BY VOLUME OF PLUS 5-INCH |




REMARKS: Samples taken where indicated by circled numbers. Trench walls caved considerably to 2' or 3' but stood nearly vertically below. Considerable weak caliche cementing in bottom 2' to 3'. Above is a generalized diagram of the north wall of the test trench.

605335

(Lbs of rock sampled) 100
(Cubic feet of rock sampled) x (Specific gravity of rock) 62.4

7 - 16 (Combined (1338)
(5-70) Bureau of R...

# LOG OF TEST PIT OR AUGER HOLE
FOR BORROW AND FOUNDATION INVESTIGATIONS

Feature: Harquahala Valley w/s  Project: Harquahala FRS  Area Designation: Reach 2
Hole No.: TT-1-GR5  Coordinates: Sta. 421+50-423+00 ℄  Ground Elevation: 1395  Approx. Dimensions: 5' x 150' x 5'
Depth to Water Level*: Not reached  Method of Excavation: Backhoe  Date: 11/22/74  Logged by: G. D. Ford

| CLASSIFICATION SYMBOL LETTER | CLASSIFICATION SYMBOL GRAPHIC | DEPTH (FEET) | SIZE AND TYPE OF SAMPLE TAKEN | CLASSIFICATION AND DESCRIPTION OF MATERIAL (SEE CHART - "UNIFIED SOIL CLASSIFICATION") GIVE GEOLOGIC AND IN-PLACE DESCRIPTION FOR FOUNDATION INVESTIGATIONS | PERCENTAGE OF COBBLES AND BOULDERS ### VOLUME OF HOLE SAMPLED (CUBIC FEET) | WEIGHT OF 3 TO 5-INCH SAMPLED (LBS) | PERCENTAGE BY VOLUME OF 3 TO 5-INCH### | WEIGHT OF PLUS 5-INCH SAMPLED (LBS) | PERCENTAGE BY VOLUME OF PLUS 5-INCH### |
|---|---|---|---|---|---|---|---|---|---|
| | | 0 | (3) 75-lb sacks | 40-60% sand, 10-40% gravel, 15-40% silt | | | | | |
| | | | | SP | | | | | |
| | | | | poorly developed, silty topsoil less than 1' thick. | | | | | |
| | | | | SM Loose, silty sand, gravelly | | | | | |
| | | 2.5 | | ML 60-80% low plasticity fines, 5% gravel, weakly caliche cemented. | | | | | |
| | | 5.0 | | SM-ML silt and sand w/ up to 20% gravel, scattered cobbles | | | | | |
| | | | | GM-SM weakly caliche cemented, 5% cobbles to 10" diam. cobbles & gravel caliche coated. | | | | | |
| | | | | GM silty gravel w/ cobbles to 8" diam. | | | | | |

640+00 641+00 641+50

PRELIMINARY SUBJECT TO REVISION

REMARKS: Samples taken where indicated by circled numbers. Trench walls caved to 2 or 3' but stood vertically below. Considerable caliche and weak cementing below 2-3'. Above is a generalized diagram of the north wall of the test trench.

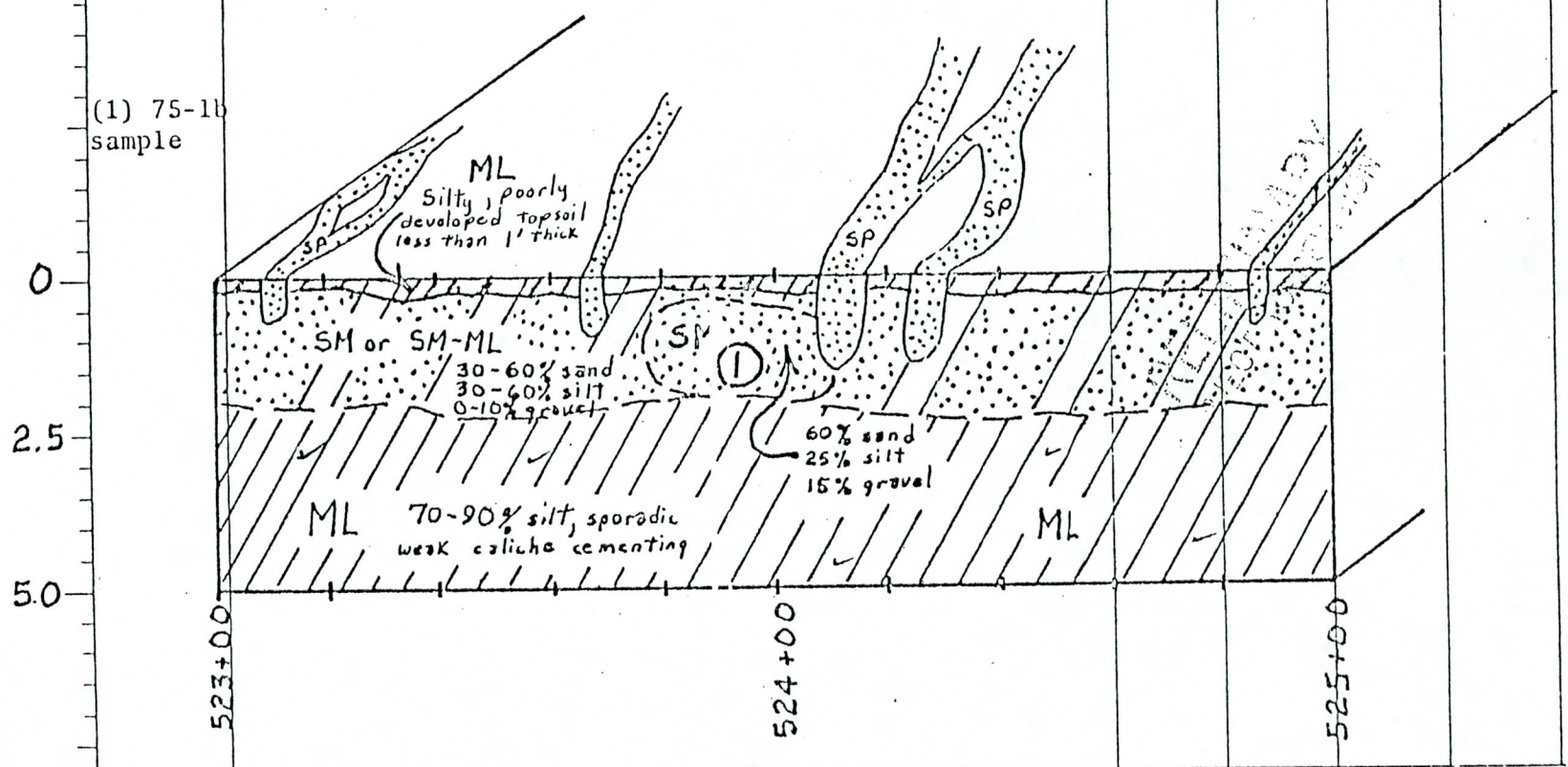
NOTES: Record water test and density test data, if applicable, under remarks.
* Record after water has reached its natural level; give date of reading adjacent to graphic symbol or in remarks.
** Applicable only to borrow pits and to foundations which are potential sources of construction materials.
*** (Bulk specific gravity of rock) 62.4 (Cubic feet of hole sampled) / (Lbs of rock sampled) 100
Record bulk specific gravity in Remarks, stating how obtained (measured or estimated).

7-1330 (Continuing 7-1330 and 7-1331A)
(6-72) Bureau of Reclamation

# LOG OF TEST PIT OR AUGER HOLE
FOR BORROW AND FOUNDATION INVESTIGATIONS

Feature: Harquahala Valley w/s  Project: Harquahala FRS  Area Designation: Reach 2
Hole No.: TT-3-GR5  Coordinates: Sta 538+00-540+00 ℄  Ground Elevation: 1395.0  Approx. Dimensions: 3' x 200' x 5'
Depth to Water Level: Not reached  Method of Excavation: Backhoe  Date: 11/26/74  Logged by: G. D. Ford

| CLASSIFICATION SYMBOL | | DEPTH (FEET) | SIZE AND TYPE OF SAMPLE TAKEN | CLASSIFICATION AND DESCRIPTION OF MATERIAL (SEE CHART - "UNIFIED SOIL CLASSIFICATION] GIVE GEOLOGIC AND IN-PLACE DESCRIPTION FOR FOUNDATION INVESTIGATIONS) | PERCENTAGE OF COBBLES AND BOULDERS | | | | |
|---|---|---|---|---|---|---|---|---|---|
| LETTER | GRAPHIC | | | | VOLUME OF HOLE SAMPLED (CUBIC FEET) | WEIGHT OF 3 TO 5-INCH SAMPLED (LBS) | PERCENTAGE BY VOLUME OF 3 TO 5-INCH | WEIGHT OF PLUS 5-INCH SAMPLED (LBS) | PERCENTAGE BY VOLUME OF PLUS 5-INCH |




REMARKS: Sample taken where indicated by circled number. Trench walls caved to 2' and stood vertically below. Above is a generalized diagram of the north wall of the test trench.

07 15

(Lbs of rock sampled) 100

Enter laboratory soil and rock density test data, if applicable, under remarks.

| By A.L.Roesler | Date 11/1/78 | Harquahala Valley W/S | Sheet 1 of 2 |
|---|---|---|---|
| Chkd by | Date | Feature Harquahala FRS | |

Details Recommended depth of foundation excavation; cutoff trench depth shown where needed.

| | ℄ Station | Elev. ℄ Dam Existing Ground | Foundation Excavation Depth(Ft) | Cutoff Trench Depth(Ft) |
|---|---|---|---|---|
| 434+65 | 433+65 | 631+00 | 1419.0 | 8.5 | 10.0 |
| 444+65 | 443+65 | 621+00 | 1412.0 | 12.5 | |
| +100 | 453+15 | 611+50 | 1405.0 | 10.0 | |
| | 464+15 | 601+50 | 1400.0 | 11.0 | 12.5 |
| | 474+15 | 591+50 | 1395.5 | 12.0 | |
| | 485+15 | 582+50 | 1395.5 | 8.0 | 10.0 |
| | 493+00 | 572+50 | 1395.3 | 8.0 | 10.7 |
| ~~504~~ | 503+00 | 562+50 | 1395.0 | 8.0 | |
| | 512+50 | 553+00 | 1397.0 | 10.5 | 15.0 |
| | 522+50 | 542+25 | 1396.0 | 5.0 | |
| | 533+00 | 532+00 | 1397.0 | 15.0 | |
| | 543+00 | 522+00 | 1396.0 | 11.5 | 13.2 |
| | 553+00 | 512+00 | 1396.0 | 8.1 | |
| | 563+00 | 502+00 | 1395.0 | 14.2 | |
| | 573+00 | 492+00 | 1395.0 | 18.0 | 20.5 |
| | 583+00 | 482+00 | 1396.0 | 13.0 | |
| | 593+00 | 472+00 | 1396.0 | 21.0 | 23.0 |
| | 603+00 | 462+00 | 1395.0 | 8.5 | 12.0 |
| | 613+00 | 452+00 | 1395.0 | 11.5 | |
| | 623+00 | 442+00 | 1396.0 | 5.5 | |
| | 633+00 | 432+50 | 1394.0 | 16.0 | |
| | 643+00 | 422+50 | 1397.0 | 18.0 | |
| | 653+00 | 412+50 | 1395.0 | 8.0 | |
| | 663+00 | 402+50 | 1396.0 | 7.0 | |
| | 673+00 | 392+50 | 1395.0 | 8.0 | |
| | 683+00 | 382+50 | 1395.5 | 16.5 | |
| | 693+00 | 372+50 | 1397.0 | 5.0 | |
| | 703+50 | 362+00 | 1397.0 | 8.5 | |
| #2 I | REACH III | 353+00 | 1396.0 | 5.0 | |
| | REACH II | 343+00 | 1397.0 | 5.5 | |
| | 732+00 | 332+50 | 1390.0 | 13.0 | |
| | 742+50 | 322+25 | 1387.0 | 15.5 | |
| | 752+50 | 313+00 | 1388.0 | 10.0 | |
| | 762+50 | 303+00 | 1394.0 | 4.5 | |
| | 772+50 | 292+25 | 1395.0 | 5.0 | |
| | 782+50 | 282+25 | 1395.0 | 7.5 | |
| | 792+50 | 272+25 | 1392.0 | 5.0 | |
| | 802+00 | 262+25 | 1395.0 | 6.0 | |
| | 811+50 | 252+25 | 1399.0 | 6.5 | |
| | 821+00 | 242+25 | 1400.0 | 4.0 | |
| | 831+00 | 232+25 | 1402.0 | 6.5 | |
| | 841+00 | 223+00 | 1400.0 | 5.0 | |
| | 851+00 | 213+50 | 1399.0 | 4.5 | |
| | [illegible] | 202+50 | 1400.0 | 7.5 | |
| | 872+00 | 192+00 | 1400.0 | 8.0 | |
| | [illegible] | 182+00 | 1395.0 | 11.7 | |
| | 891+50 | 172+80 | 1398.0 | 12.0 | |
| | 902+00 | 162+50 | 1397.0 | 8.0 | |
| | 912+50 | 152+50 | 1397.0 | 7.5 | |

# ARIZONA WATER COMMISSION

## Computation Sheet

| By | Date | Project | Sheet 2 of 2 |
|---|---|---|---|
| Chkd. by | Date | Feature | |

Details

| | ℄ Station | Elev. ℄ Dam Existing Ground | Foundation Excavation Depth (Ft) |
|---|---|---|---|
| 922+00 | 142+00 | 1398.0 | 8.0 |
| 924+00 | 132+00 | 1399.0 | 9.0 |
| 936+00 | 128+00 | 1400.8 | 4.3 |
| 937+00 | 127+00 | 1400.0 | 4.6 |
| 937+50 | 126+50 | 1400.0 | 4.8 |
| 938+00 | 126+00 | 1399.7 | 4.8 |
| 938+50 | 125+40 | 1394.0 | 0.5 |
| 942+00 | 122+00 | 1397.0 | 6.0 |
| 952+00 | 112+00 | 1398.0 | 8.0 |
| 964+00 | 101+00 | 1400.0 | 10.0 |
| 971+00 | 90+80 | 1397.0 | 6.0 |
| 984+00 | 81+00 | 1398.0 | 8.0 |
| 997+00 | 71+00 | 1397.0 | 7.0 |
| 1012+00 | 61+50 | 1399.0 | 9.0 |
| 1013+00 | 51+50 | 1397.0 | 8.0 |
| 1021+50 | 41+00 | 1396.0 | 8.0 |
| 1032+00 | 30+50 | 1390.0 | 6.0 |
| 1043+00 | 20+00 | 1381.0 | 6.0 |

AZ HAVASUPAI VALLEY WPD HAVQ FRS

RJM 2/12/80 11 15

FOUNDATION DESIGN

2. ANALYSIS OF GEOLOGY REPORT STATEMENTS

a. PRELIMINARY GEOLGIC INVESTIGATION p23 (FOR REACH 1)

RESTATEMENT OF THE SECTION IS AS FOLLOWS:

WHERE FOUNDATION MATERIALS CONTAIN LESS THAN 10 % PASSING THE NO 200 SEIVE, FOUNDATION PREPARATION SHOULD CONSIST OF 1 FOOT OF STRIPPING AND A KEY TRENCH 5 FEET DEEP, 15 FEET WIDE. CONSOLIDATION OF THE FOUNDATION IS EXPECTED TO TAKE PLACE DURING CONSTRUCTION IF THE FILL MATERIAL IS PLACED AT NO LESS THAN OPTIMUM MOISTURE AND COMPACTED AT SOMEWHAT GREATER THAN NORMAL COMPACTIVE EFFORT.

COMMENT:

1 TABLE A-23 SPEC 23 INSTRUCTIONS PERMIT CLASS A, B OR C COMPACTION. THEREFORE REFERENCE TO ROLLING THE FILL AND STANDARD COMPACTION WAS MODIFIED.

AZ HALQ VALLEY WPP HALQFLS
RJM 2/12/80
FOUNDATION DESIGN 12 15

2 THE PRINCIPAL IMPLIED IS THAT NO ATTEMPT WILL BE MADE TO REMOVE THE UNCONSOLIDATED MATERIAL IN COARSE GRAINED FOUNDATIONS SINCE CONSTRUCTION EFFORT WILL PERFORM THE CONSOLIDATION. ONLY STRIPPING AND A PARTIAL CUTOFF TRENCH IS REQUIRED.

---

b. PRELIMINARY GEOLOGIC INVESTIGATION P29 (FOR REACH 2)

RESTATEMENT OF THE SECTION IS AS FOLLOWS:

THE SAME CONSTRUCTION PROCEDURES, FOUNDATION PREPARATION AND DESIGN SHOULD BE FOLLOWED FOR REACH 2 AS RECOMMENDED FOR REACH 1, THAT IS,

a. STRIP THE FOUNDATION
b. CONSTRUCT A PARTIAL CUTOFF TRENCH
c. OVER COMPACT AT OPTIMUM MOISTURE OR GREATER TO OBTAIN FOUNDATION CONSOLIDATION DURING CONSTRUCTION.

AZ HARO VALLEY WPP HARO FRS
RSM 2/12/80
FOUNDATION DESIGN 13 15

C. PRELIMINARY GEOLOGIC INVESTIGATION
p30, 31 (FOR REACH 2)

TWO METHODS ARE ACCEPTABLE FOR EFFECTIVELY COMPENSATING FOR ANTICIPATED FOUNDATION SETTLEMENT.

1. EXCAVATION OF A KEY TRENCH 5 FT DEEP, 15 FEET WIDE AND PREWETTING THE FOUNDATION TO A DEPTH OF 10 FEET.
2. REMOVAL AND RECOMPACTION OF THE LOOSE FOUNDATION MATERIAL ACTUAL FOUNDATION EXCAVATIONS EXPECTED ARE FROM 4.5 TO 8.0 FEET DEEP WITH AN AVERAGE DEPTH OF 6.75 FEET. THIS IS THE RECOMMENDED METHOD

d PRELIMINARY GEOLOGIC INVESTIGATION
p30 (FOR REACH 2)

RESTATEMENT OF THE SECTION IS AS FOLLOWS:

FOUNDATION SETTLEMENT SHOULD OCCUR DURING CONSTRUCTION

e. PRELIMINARY GEOLOGIC INVESTIGATION
p33 (FOR REACH 2)

RESTATEMENT OF THE SECTION FOLLOWS:

FIRM AND COMPETENT MATERIAL WAS ENCOUNTERED AT DEPTHS BETWEEN 4.5 AND 8.0 FEET.

AZ HARQ VALLEY WPP HARQ FRS
RJM 2/12/80
FOUNDATION DESIGN 14 15

f. GEOLOGIC INVESTIGATION 1978
P6 (REACH 1)

RECOMMENDED FOUNDATION EXCAVATION VARIES FROM 0.5 TO 15.5 FEET DEEP WITH THE AVERAGE DEPTH AT 7.0 FEET. A PARTIAL CUTOFF SHOULD BE INSTALLED TO PREVENT PRESSURES AT THE DOWNSTREAM TOE.

g. GEOLOGIC INVESTIGATION 1978
P 7-8 (REACH 2)

THE SM AND ML SOILS APPEAR TO BE THE LOOSE SURFACE MATERIALS THAT SHOULD BE REMOVED AND RECOMPACTED.

h. GEOLOGIC INVESTIGATION 1978

BURIED CHANNELS OF SAND ARE EXPECTED ALL ALONG REACH 2.

AE HARO VALLEY WPD HARO FRS
RJM 2/12/80
FOUNDATION DESIGN 15 15

SUMMARIZE GEOLOGIC RECOMMENDATIONS.

1. THE GEOLOGIST HAS GIVEN CONFLICTING STATEMENTS FOR FOUNDATION TREATMENT FOR REACH 1. THE PRELIMINARY INVESTIGATION REPORT RECOMMENDS 1 FOOT STRIPPING WITH A 5 FOOT KEY TRENCH. ~~THE~~ ~~[illegible]~~ 1978 REPORT STATES THAT THE FOUNDATION EXCAVATION WILL VARY FROM 0.5 TO 15.5 FEET DEEP AND THAT A PARTIAL CUTOFF TRENCH SHOULD BE INSTALLED TO PREVENT PRESSURES ON THE DOWNSTREAM TOE. THIS DESIGNER PREFERS THE METHOD RECOMMENDED IN THE 1978 REPORT AND WILL ~~FOLLOW~~ USE IT.

2 LOOSE & UNCONSOLIDATED MATERIAL WILL BE REMOVED IN FOUNDATION EXCAVATION.

3 SM & ML MATERIAL WILL BE CONSIDERED LOOSE UNLESS THE LOG STATES OTHERWISE.

---

ADDITIONAL CRITERIA

1. WHERE POSSIBLE ~~X~~ THE CUTOFF TRENCH WILL BE EXTENDED INTO RELATIVELY IMPERVIOUS MATERIAL

FOUNDATION - REACH-1

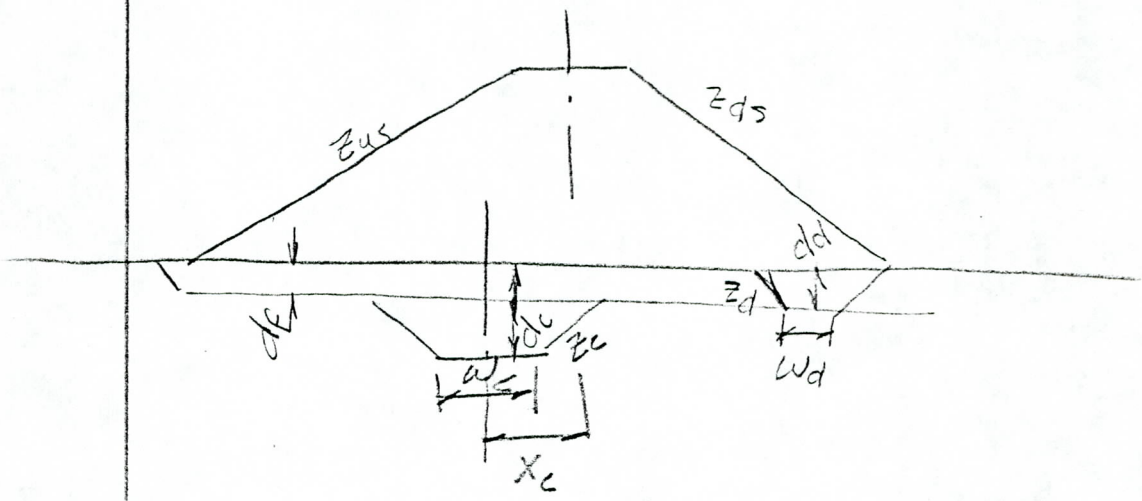
Harquahala Fcs

RJM 4-8-80

Reach 1

1 32

Req'd




1. $d_f$ Depth of foundation excavation
2. $X_c$ Location of cutoff trench
3. $d_c$ Depth of cutoff trench
4. $W_c$ Width of cutoff trench
5. $Z_c$ side slope cut-off trench
6. $W_d$ Width of drain *
7. dd Depth of drain
8. $Z_d$ side slope drain
9. $Z_{us}$ upstream slope
10. $Z_{ds}$ downstream slope

* if req'd

Az Harquahala FRS
PJM 4-8-80
Reach 1

2 32

1. df Depth of foundation excavation

Given

a. Foundation excavation line in geology report 1978 - Final
b. 1' depth in Geology Report - Preliminary
c. ~~in place~~ densities

| Sta | Pit or hole | Depth | Sym. | $\gamma_d$ | $\gamma_{max}$ | D % | % $\gamma$ max | % lgr than tested |
|---|---|---|---|---|---|---|---|---|
| 742+50 | 84 | 0-8 | GM | 101.9 | | | | |
| 777+50 | 9 | 1.0 | SM | 96.7 | 116.5 | 83.0 | | 27 |
| | | 5.0 | GM | 92.9 | 116.0 | 80.1 | | 43 |
| | | 10.0 | GM | 90.3 | 114.0 | 79.6 | | 52 |
| 882+00 | 86 | 12-15 | GM | 97.4 | | | | |
| 904+00 | 10 | 5.0 | GM | 94.1 | 113.7 | 94.0 | | 51 |
| | | 10.0 | GP-GM | 126 | 121.4 | 53.9 | 93 | — |
| 1044+00 | 11 | 1.0 | GM-SM | 82.6 | 114.1 | 72.4 | | 21 |
| | | 12.5 | GP-GM | 112.8 | 116.7 | 74.4 | 97 | — |

Solution:

1. Examination of the in place densities @ Sta 904+00 & 1044+00 show relative densities of 58.9 and 74.4. Earth Manual 0501 p 27 states that relative densities of 70 percent is considered satisfactory for most conditions. Based on this reference

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RM 4-8-60
Reach 1



one of the 2 tests made for relative density in Reach 1 is unsatisfactory. The only significant difference in the properties of the 2 samples is the value for maximum density. Gradation, specific gravity, minimum density and in place density values are similiar. Based on the above similiarities, the recorded difference in maximum density and the fact that there are only 2 tests to judge the entire reach by the conclusion is reached, that by itself the relative density values obtained are unreliable.

2. The dry densities for soils at stations 777+50, 882+00, 904+00 and 1044+00 were determined from the -#4 material. Percent of maximum density for the 5 samples ranged from 74.4 to 94.0. With exception of the lowest value, which was for a sample at a depth of 1ft., the values were 80% or above. A value of 80% is considered acceptable.

3. The predominate material in reach 1 is a silty gravel. Frequently

Ltr Rim 4-8-80 Harquahala FRS

Reach 1 4 32

there are cobbles and boulders particularly at the location of the highest fill. P212 Design of Small Dams USDI states that generally settlement is not a problem in coarse grained pervious foundations. Since the same coarse grained material will be used in the embankment, cracking is not considered a problem.

4 Based on the majority of the densities of the -#4 material and the coarse nature of the foundation and embankment material a foundation excavation depth of 1 foot is recommended.

---

2. Xc Location of cutoff Trench

Design of Small Dams USDI p223 recommends that the cutoff trench be located upstream from the centerline of the dam but to keep it within the limits of the impervious portion of the dam. It is expected that 6m³ of material will be used as from the ± of the dam. Since the minimum height of dam in

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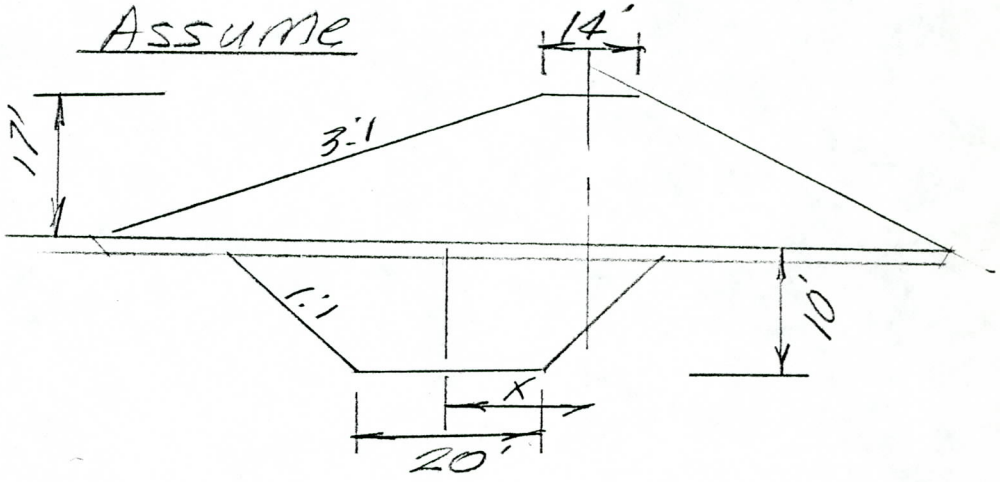
RM 4-8-20
Reach 1

5 32

this reach is 17 feet if embankment top width & slope and trench bottom width, depth and slope are known the distance from the ℄ dam could be selected

Assume




$$\frac{14}{2} + (17)(3) = x + \frac{20}{2} + 10(1)$$

$x = 38'$ say 35'

check later.

---

3 d. Depth of cut off Trench

~~To determine this item it will be necessary to perform a seepage analysis for varying depths since a total cutoff is not possible~~

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PJM 4-9-80

6 32

3a Permeability

Given

| Sta | Pit or hole | Depth | Symb. | K ft/da |
|---|---|---|---|---|
| 750+50 | AP14Z | 10-20 | SM | 1.2 |
| e 21+00 | DH40 | 4.8-10.5 | GP-GM | 1.81 |
| 927+00 | AP15Z | 11-21 | SM | 0.90 |
| 1044+50 | DH314 | 10-14 | GM | 0.51 |

From Seepage, Drainage and Flow Nets H.R. Cedergren. Fig 2.3 Permeability and drainage characteristics of soils, values of coefficient of permeability for clean sands, clean sand and gravel mixtures

$1.1\ cm/sec > K > 10^{-3}\ cm/sec$

$2330\ ft/da > K > 2.33\ ft/da$

From Design of Small Dams 1st ed 1960 Fig 9 - for ave permeability values compacted to 100 percent Standard dry density D698

| Symb | $\gamma_{dmax}$ pcf | Permeability, K (fpd) |
|---|---|---|
| GW | > 119 | $74 \pm 36$ |
| GP | > 110 | $175 \pm 93$ |
| GM | > 114 | > 0.00087 |
| SM | $114 \pm 1$ | $0.021 \pm 0.013$ |

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RJM 5-5-80
Foundation Design K-1 7 32

The natural blanket-Aquifer analysis of Basic Soils Mechanics -SM10-. p12-19 is used in analyzing safety factor for uplift pressures at the toe of the dam at the following stations

1. 772+50
2. 891+50
3. 902+00
4. 912+50

The following values of permeability are used

Embankment

| | |
|---|---|
| GM | K= 0.0010 |
| GP-GM | K=0.50 |
| GP | K=175 |
| GW | K=75 |
| SM | K=0.0010 |

Foundation

| | |
|---|---|
| GM | K= 1 |
| SM | K= 1 |
| GP-GM | K= 10 |
| GW | K= 100 |
| GP | K=1000 |

| STATE | | PROJECT | | |
|---|---|---|---|---|
| AZ | | Harquahala FRS | | |
| RJM | DATE 4-25-80 | CHECKED BY | DATE | JOB NO. |

SUBJECT

SHEET 8 OF 32

TP #4
TP 9

Given:

$\gamma_d = 101.9$ $\quad G_s = 2.58$

Find: $\gamma_{sub}$

Solution:

$$\gamma_{sub} = \gamma_d - (1-n)\gamma_w$$

$$n = \frac{e}{1+e}$$

$$e = \frac{G_s \gamma_w}{\gamma_d} - 1$$

$$= \frac{2.58(62.4)}{101.9} - 1 = 0.580$$

$$n = \frac{0.580}{1.580} = 0.367$$

$$\gamma_{sub} = 101.9 - (1-0.367)62.4$$

$$= \underline{62.4 \text{ pcf}}$$

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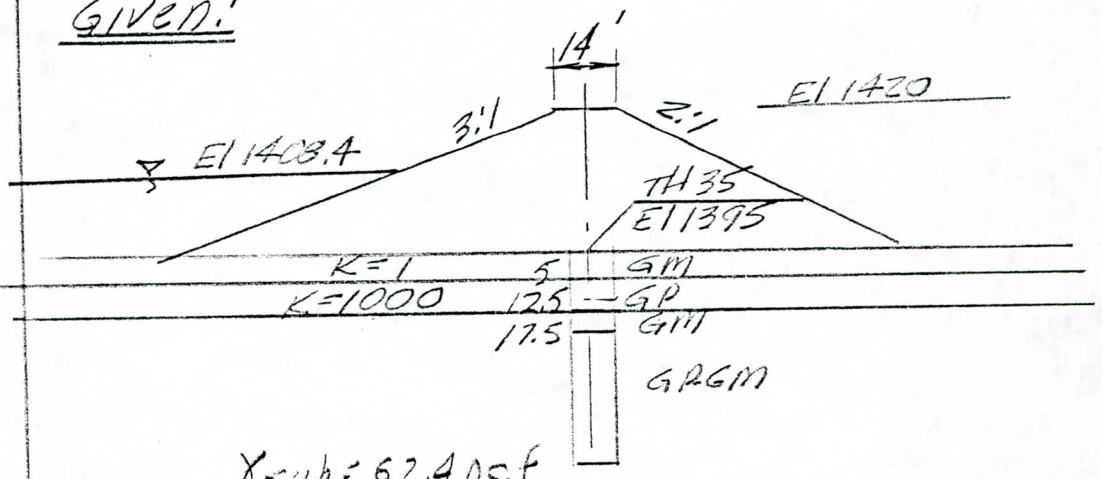
Foundation Design 2-1 1 32

Determine uplift at toe at Sta 772+50

Given:




Solution:

Ref Basic Soils Mechanics SM10 p12-15
Natural Blanket - Aquifer Equations

$L_1$ = eff length of u.s. nat'l blanket
$L_2$ = length of base = 139'
$L_3$ = eff length of d.s. nat'l blanket
h = net head = 13.4
d = min thickness aquifer = 7.5'
$z_1$ = thickness u.s. nat'l blanket = 5'
$z_2$ = thickness d.s. nat'l blanket = 5'
$K_b$ = vert perm blanket = 1
$K_f$ = horiz perm coeff. aquifer = 1000
$h_o$ = pressure head under blanket @ d.s. toe
$h_c$ = critical head under blanket @ d.s. toe

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RJM 4-25-80
Foundation Design L-1 10 32

$$L_1 = \sqrt{\frac{K_f d \bar{E}_L}{K_b}}$$

$$= \sqrt{\frac{1000(7.5)(5)}{1}} = 193.6$$

$$L_3 = \sqrt{\frac{K_f d \bar{E}_2}{K_b}}$$

$$= \sqrt{\frac{1000(7.5)(5)}{1}} = 193.6$$

$$h_o = \frac{hL_3}{L_1 + L_2 + L_3}$$

$$= \frac{13.4(193.6)}{193.6 + 139.0 + 193.6} = 4.93$$

$$h_c = \bar{E}_2 \frac{\gamma_{sub}}{\gamma_w}$$

$$= \frac{5(62.4)}{62.4} = 5.00$$

$$F_h = \frac{h_c}{h_o} = \frac{5.00}{4.93} = 1.014 < 1.5 \text{ NG.}$$

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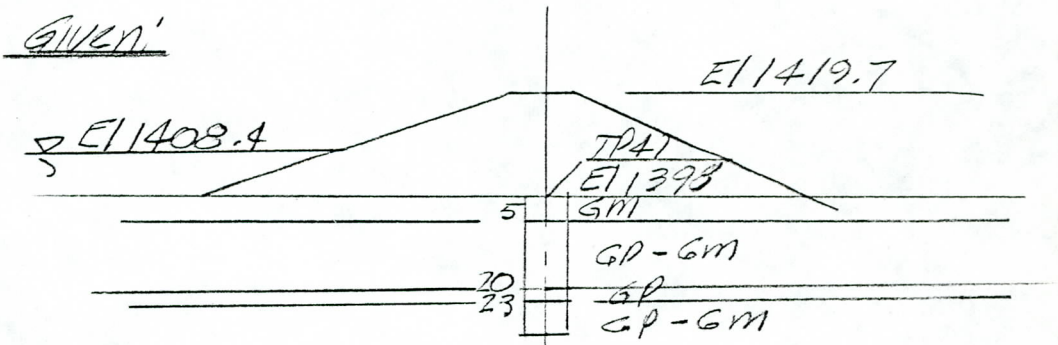
PJM 4-25-80
Foundation Design R-1 11 32

Determine: Uplift @ toe Sta 991+50

Given:




Assume permeability in GP-GM layer is downward because of GP layer. Therefore should be no problem to upper GM layer

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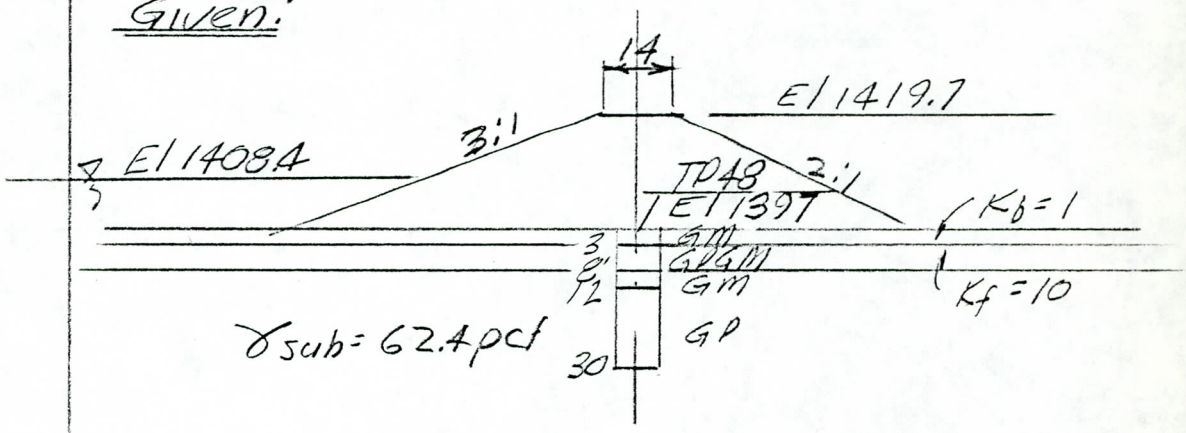
RM 4-25-90
Foundation Design R-1 12 32

Determine uplift @ toe @ sta 902+00

Given:




Solution: SM10 p 12-19

$L_2 = 127.5$
$h = 11.4$
$d = 5'$
$z_1 = 3' = z_2$

$$L_1 = \sqrt{\frac{K_f d z_1}{K_0}}$$

$$= \sqrt{\frac{10(5)(3)}{1}} = 12.25 = L_3$$

$$h_0 = \frac{h L_3}{L_1 + L_2 + L_3} = \frac{11.4(12.25)}{24.5 + 127.5} = 0.919$$

$$h_c = z_2 \frac{\gamma_{sub}}{\gamma_w} = \frac{3(62.4)}{(62.4)} = 3$$

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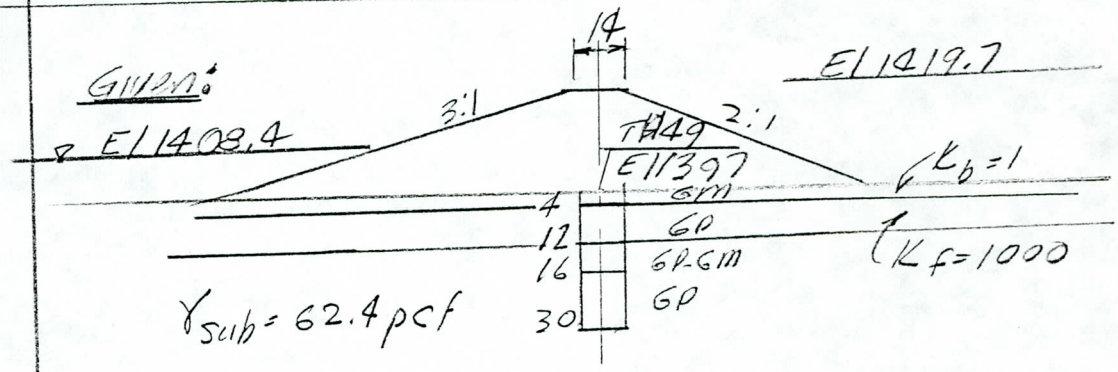
PJM 4-25-80
Foundation Design R-1 13 32

$$F_n = \frac{h_c}{h_o} = \frac{3}{0.919} = 3.26 \; 71.5 \text{ OK}$$

AZ
PJM 4-25-80 Harquahala FRS
Foundation Design R-1 14 32

Determine: Uplift @ toe Sta 912+50




Solution: SM10 p12-19

$L_2 = 127.5$
$h = 11.4$
$d = 8$
$z_1 = z_2 = 4$

$$L_1 = \sqrt{\frac{k_F d z_1}{k_0}} = \sqrt{\frac{(1000)(8)(4)}{1}} = 178.9 = L_3$$

$$h_0 = \frac{h L_3}{L_1 + L_2 + L_3} = \frac{(11.4)(178.9)}{358 + 127.5} = 4.2$$

$$h_c = z_2 \frac{\gamma_{sub}}{\gamma_w} = \frac{4(62.4)}{62.4} = 4$$

$$F_n = \frac{h_c}{h_0} = \frac{4}{4.2} = 0.952 \quad NG - < 1.5$$

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RJM 5-5-80
Foundation Design R-1. 15 32

Since Bennett had based his analysis on a steady seepage condition it is reasonable to assume that the safety factor could be reduced where steady seepage conditions are not likely to exist as is the case at the Harquahala site. Conditions of saturated foundation will not exist at the beginning of storms of significance nor is a full phreatic line likely to develop. Based on the above assumption a safety factor of 1.01 is used to determine the minimum depth of cutoff in GM & SP-GM surface material.
∴ Based on a SF = 1.014 @ Station 772 +50 a minimum cutoff depth of 5.0 ft will be used. Washes of clean gravel will be positive cutoff. In those areas where it appears that washes exist beyond the limits of the test data toe drains will be used.

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RJM 5-6-80
Foundation Design R-1 16 32

4 Wc Width of C/O trench

Since C/O is likely to go to depths of 20' or beyond Use a 20 bottom width so equipment can maneuver

$W_c = \underline{20'}$

---

5 Zc side slope - C/O trench

a. Safety

Assume a soil not quite a compacte angular gravel

"Safety and Health Regulations for Construction" USDI BuRec

For Compact angular gravels
$z = 1.5$

For Ave soils
$z = 1$

USE $z = 1$

AE Harquahala FRS
RJM 5-6-80
Foundation Design R-1 17 32

6. Width of drain

in lieu of drain geometry shown on sheet provide a vertical french drain with a perforated underdrain

Design drain systems for the following locations.

1. Sta 1041+00 to Sta 1051+00

2. Sta 790+00 to Sta 795+00

Provide the following information

1. Size & type of underdrain pipe
2. Slope & depth of underdrain - profile
3. Interval of outlets
4. Size and length of outlets

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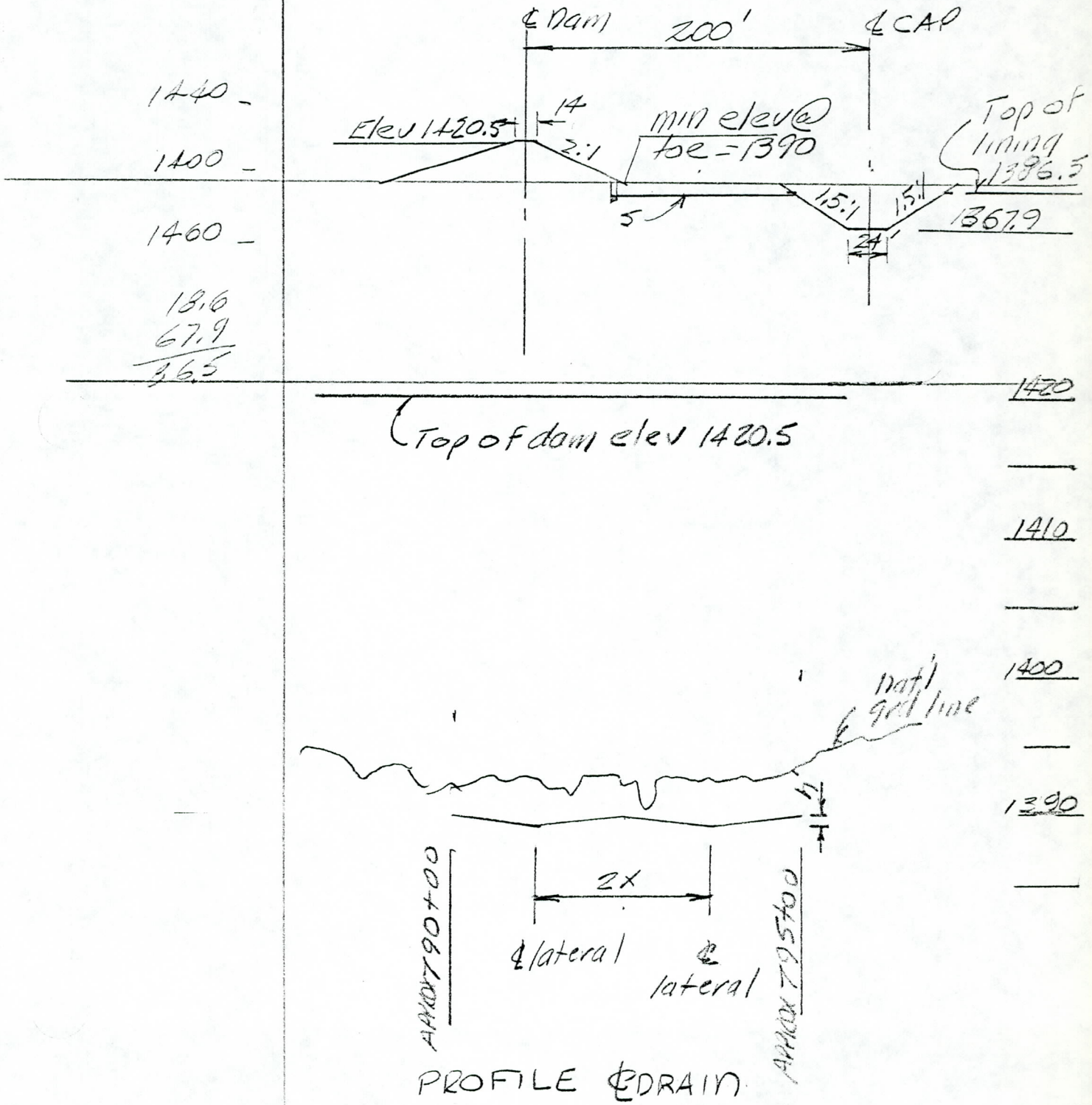
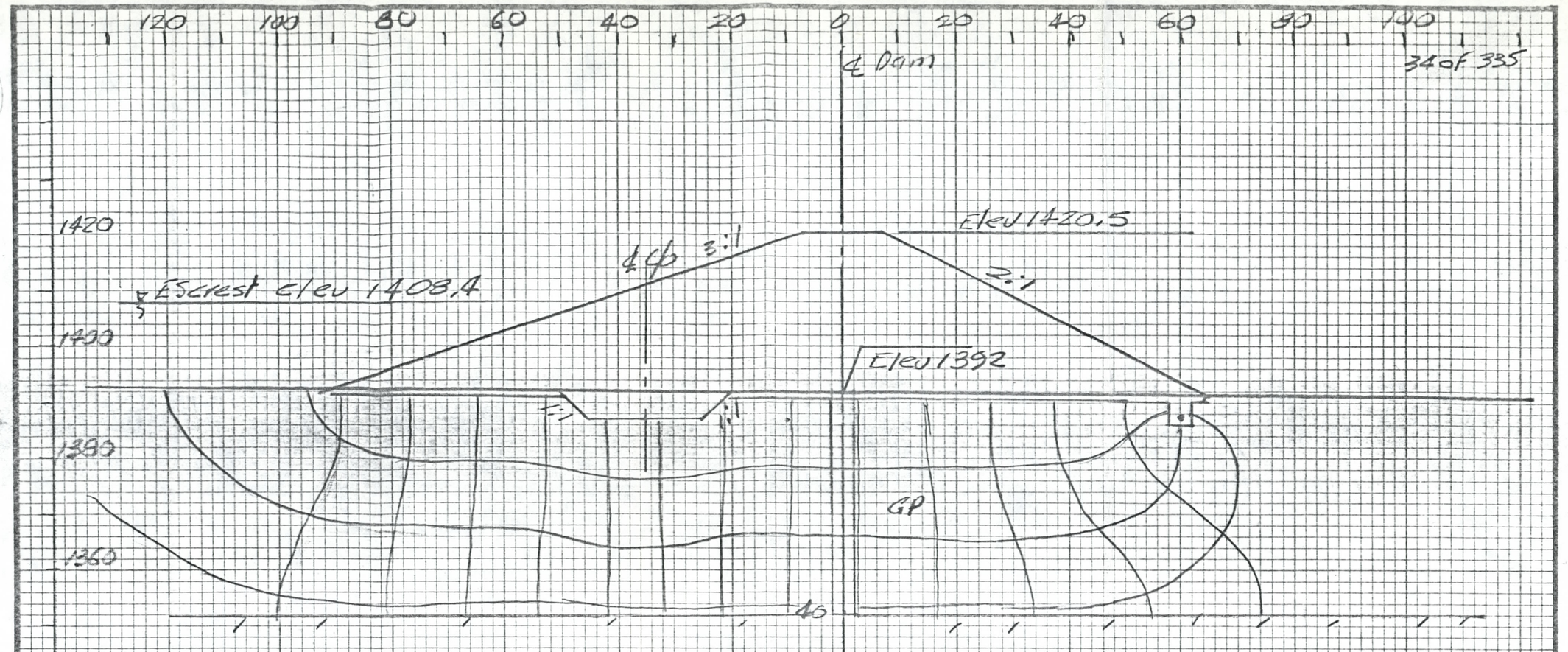
RM 5-6-80
Foundation Design 2-1

18 32

Underdrain - Sta 790+00 to Sta 795+00






ASSUME:

1. impervious boundary @ 40' depth
2. K = 1000 ft/da - GP
3. K = 100 ft/da - GW
4. K = 500 ft/da will be used based on the following observations:
   a. Gradation curves for available GP samples show the material to be GW.
   b. Classification of the GP at the site was made on samples obtained from auger borings.

STA 792+50

$Q = Kh\frac{n_f}{n_d}$

K = 500 ft/da
h = 16.4 ft
$n_f$ = 3.1
$n_d$ = 14

$Q = 500(16.4)\left(\frac{3.1}{14}\right)(.0000157)$

$= 0.0210$ cfs/ft

Harquahala FRS
Sta 790+00 to 795+00
Toe drain Design

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Drawn | Title
Traced | Sheet No. 19 of 32 | Drawing No.
Checked

SCS-ENG-315A REV 8-75

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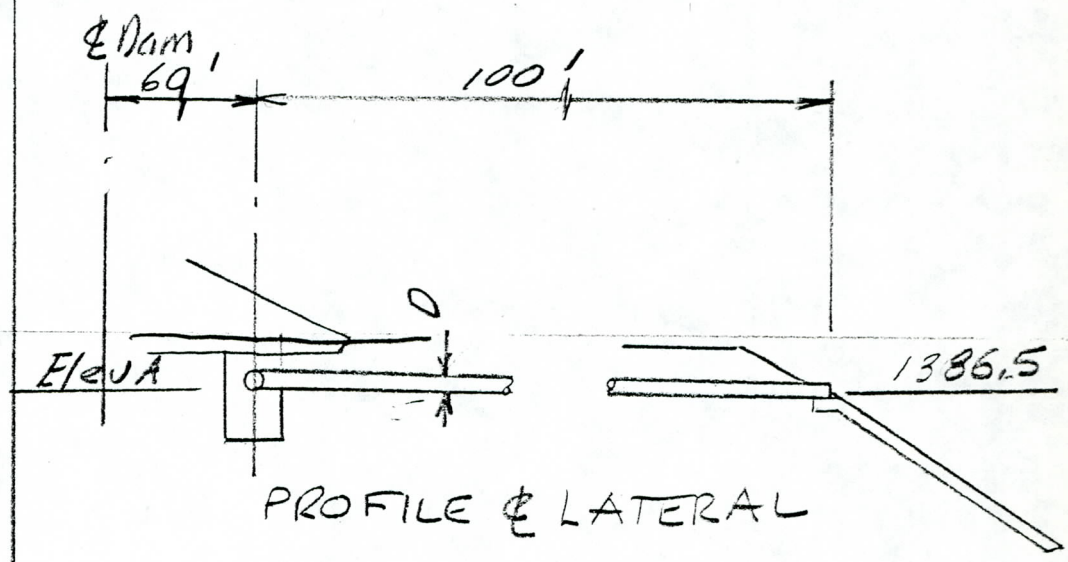
PJM 5-7-80
Foundation Design-R-1 20 32




PROFILE ℄ LATERAL

½" dia Perf

From SM note 3

For Asbestos Cement Pipe ASTM C508

| Dia | Discharge - q cfs/ft | | | |
|---|---|---|---|---|
| | h=0.5 | h=1.0 | h=1.5 | h=2.0 |
| 4 | .0054 | .0075 | .0093 | .0101 |
| 6 | .0054 | .0075 | .0093 | .0101 |
| 8 | .0054 | .0075 | .0093 | .0101 |
| 10 | .0080 | .0113 | .0190 | .0162 |
| 12 | .0080 | .0113 | .0190 | .0162 |

Asbestos cement underdrain is preferred to CMP because it is non-corrosive.

At Harquahala FRS
RJM 5-20-80
Toe Drain

21 32

$$V = \frac{1.486}{n} R^{2/3} S^{1/2} \qquad Q = VA$$

d
S
V
Q
F

→ FIX 7
→ FIX 3

114.3 for n = 0.013

Stable openchannel flow velocities and discharges for 6, 8, 10 and 12 inch dia AC pipe

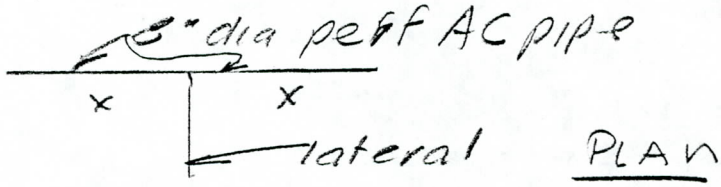
HP 41 Program

At Harquahala FRS
RM 5-24-80
Toe Drain

22 32

Try 8" toe drain

$q = 0.0210$ cfs/ft

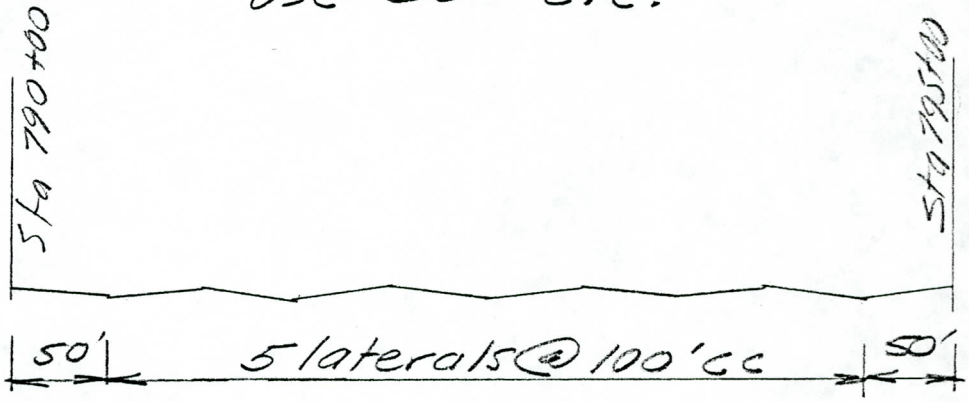



$x = Q_{max}/q$

$Q_{max} = 1.106$ cfs @ $S = 1.006\%$

$x = 1.106/0.0210 = 52.7$ ft

Use 50' c.c.

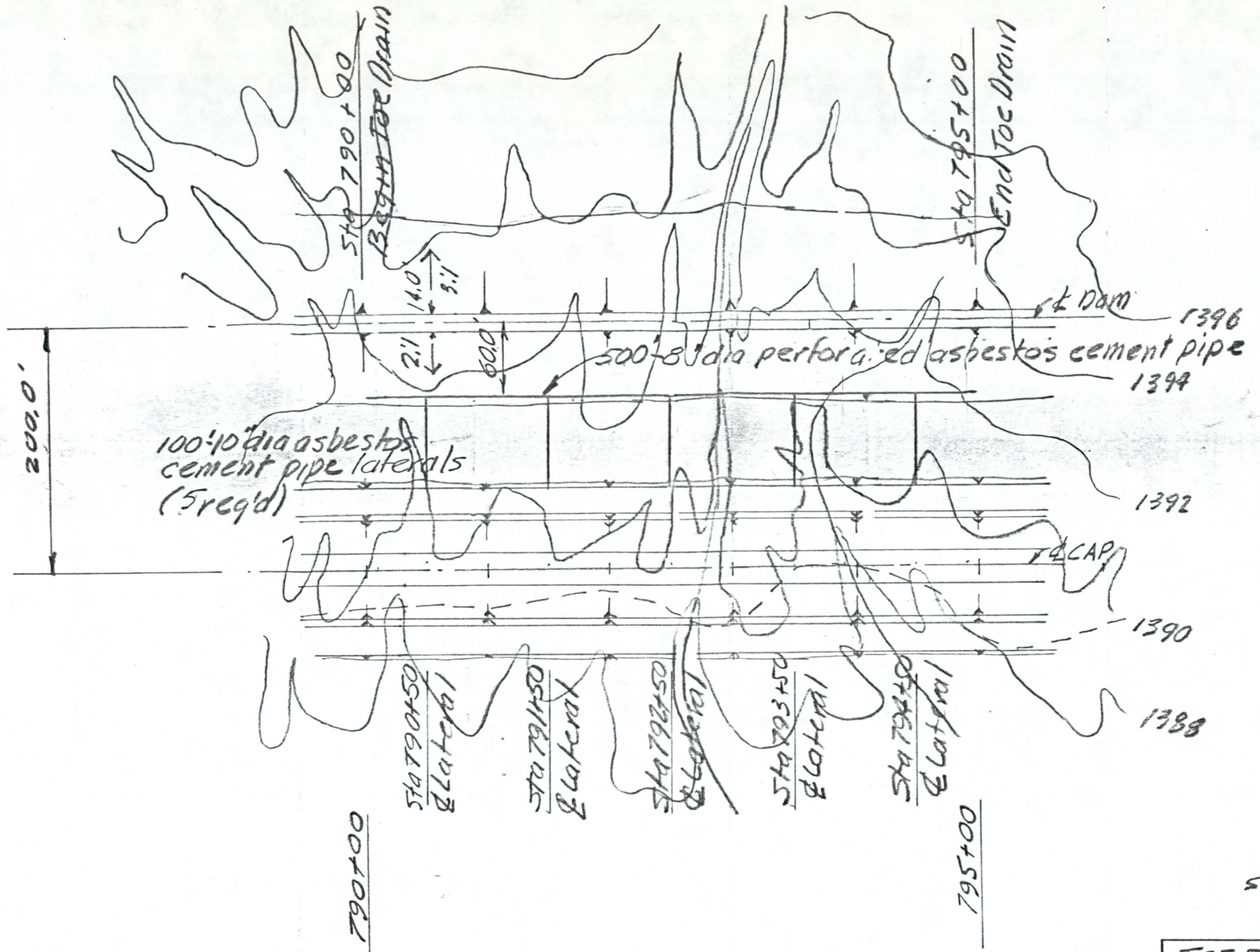



Laterals

$Q_L = 2Q_0 = 2(1.106) = 2.21$ cfs

Try 10" dia AC pipe

OK USE @
min slope
$S = 0.0072$




PLAN TOE DRAIN
STA 790+10 TO STA 794+90

Scale 1"=100'

No scale

TOE DRAIN STA 790+10 TO STA 794+90
HARQUA HALA VALLEY WPP, AZ
HARQUAHALA FRS

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| | |
|---|---|
| Designed PJM 5-80 Date | Approved by |
| Drawn | Title |
| Traced | Title |
| Checked | Sheet No. 23 of 32 — Drawing No. 5 |

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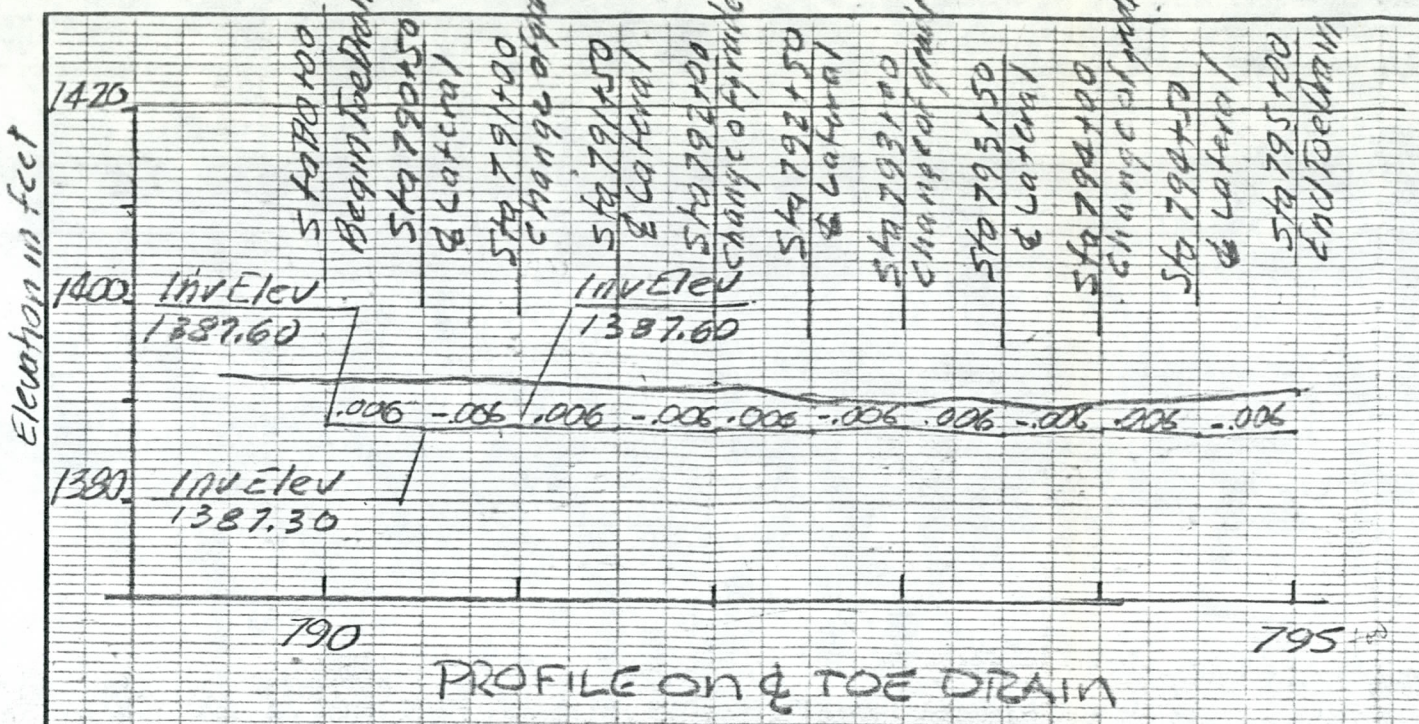
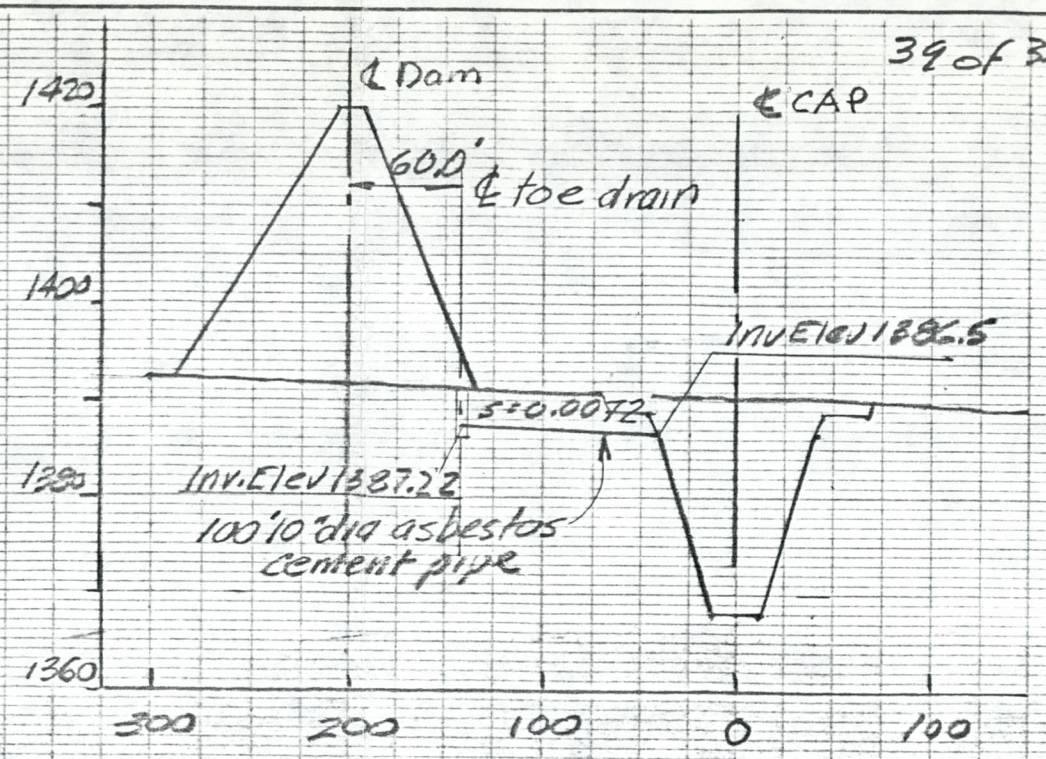
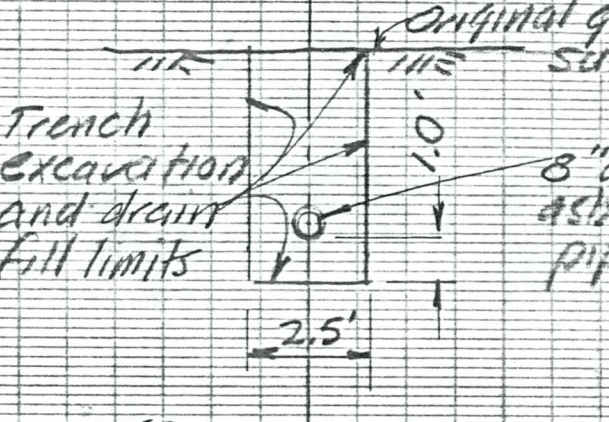


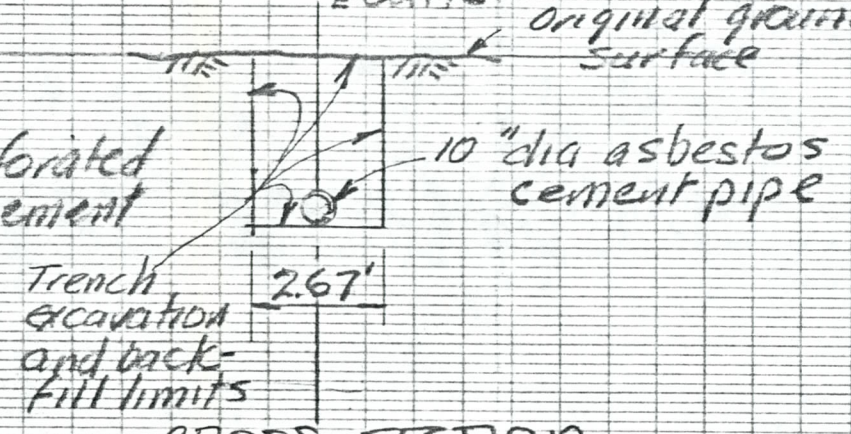

PROFILE on ℄ TOE DRAIN




PROFILE on ℄ STA 793+00 ℄ CAP




CROSS SECTION TOE DRAIN TRENCH




CROSS SECTION LATERAL TRENCH

PROFILE AND CROSS SECTIONS
TOE DRAIN STA 790+10 TO STA 794+20
HARQUAHALA VALLEY NDP AZ
HARQUAHALA FRS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

| | | | |
|---|---|---|---|
| Designed PJM | Date 5/80 | Approved by | |
| Drawn | | Title | |
| Traced | | Title | |
| Checked | | Sheet No. 24 of 32 | Drawing No. |

SCS–ENG–316A (Rev. 1–76)

Az
RJM 5-9-80

Harquahala FRS

25 32

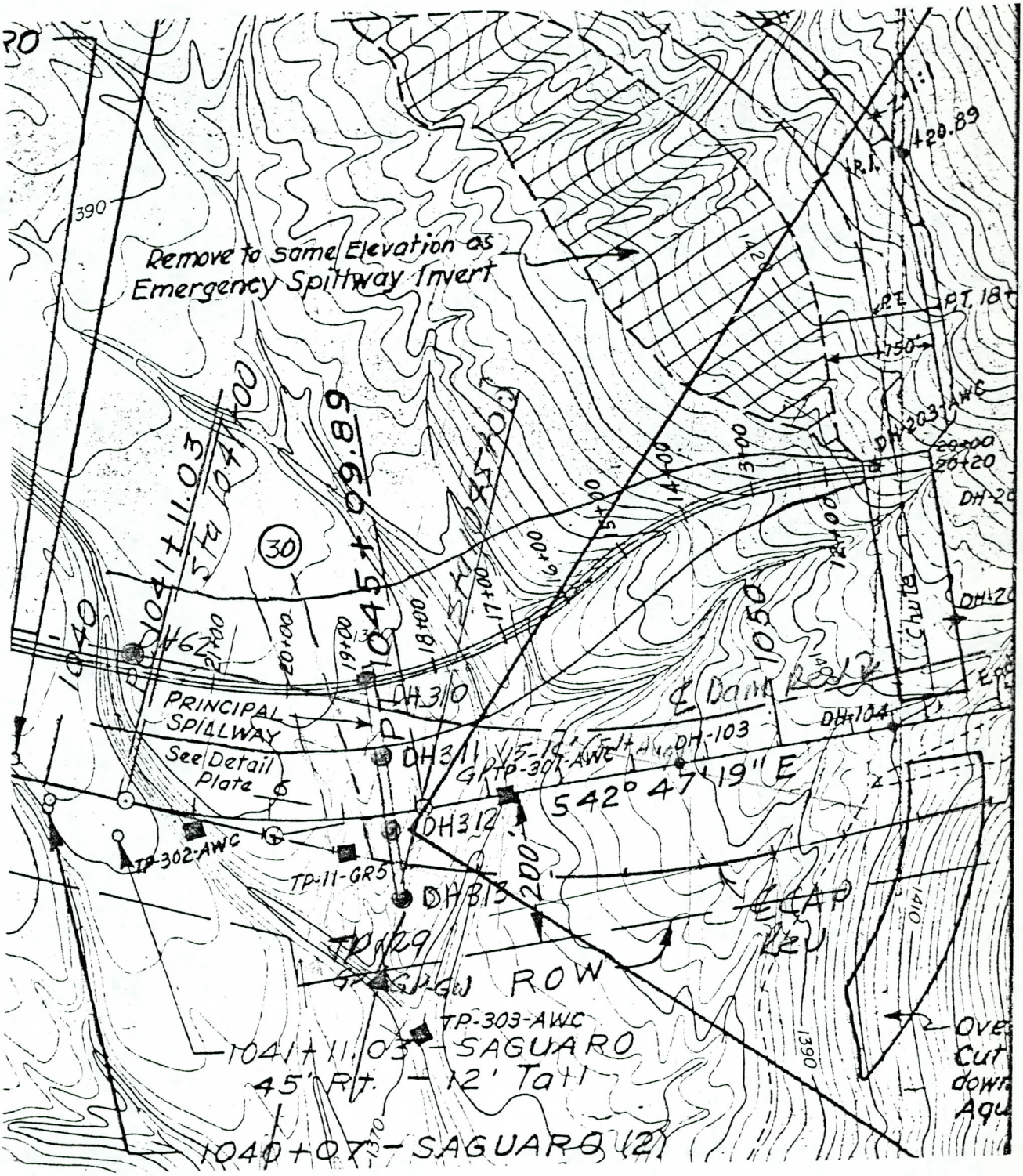
Design a drain to intercept the buried wash between Sta 1041+00 and 1051+00

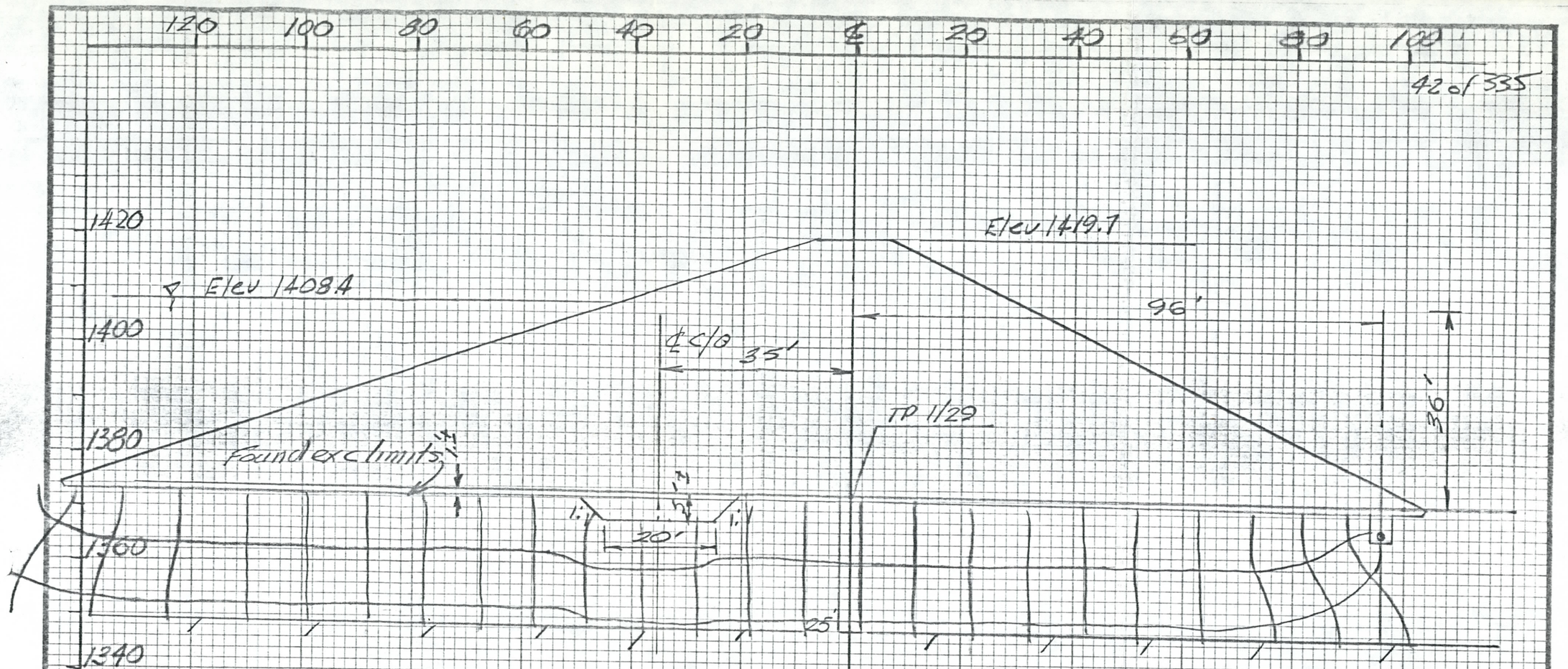
Procedure

1. plot all test pits in area on plan w/ latest ℄ dam & CAP ℄
2. From Geology logs define limits of wash ⊄.
3. Set likely limits @ ℄ dam using ℄ CAP Sta
4. Using deepest pit as depth to impervious boundary determine discharge for material corresponding to a GP-GW
5. Sketch 3 Alternative comingations of underdrain and outlet.
6. Select most favorable alternative
7. Design drain & outlet

AZ Harquahala FRS
RJM 5-9-80
Foundation Design R-1

26 32






Assume:
1. Impervious boundary @ 25' depth
2. K = 500 ft/day

$Q = Kh \frac{n_F}{n_d}$ $h = 36'$ $n_f = 2.2$ $n_d = 25$

$Q = 500(36)\left(\frac{2.2}{25}\right)(0.00001157) = 0.01833 \text{ cfs/ft}$

Harquahala FRS
Sta 1041+00 - 1045+00
Toe Drain Design

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed RJM 5/80 Approved by ____ Title ____
Drawn ____ Title ____
Traced ____ Sheet No. 27 of 32 Drawing No.
Checked ____

SCS-ENG-315A REV 8-75

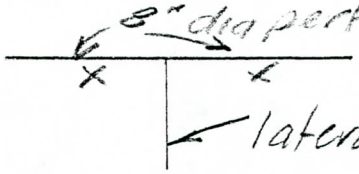
AZ
PJM 5-21-80
Toc Drain

Harquahala FRS

28 32

Try 8" under drain system

$q = 0.01833$ cfs/ft

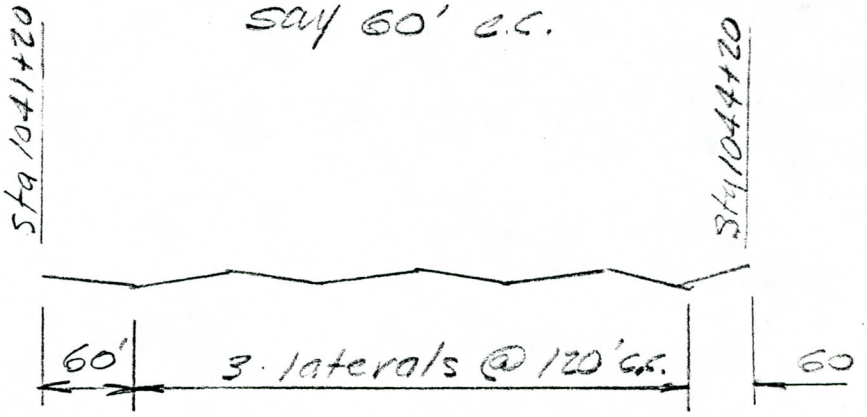



$x = Q_{max}/q$

$Q_{max} = 1.106$ cfs @ $S = 0.006$ ft/ft

$x = 1.106/0.01833 = 60.4'$

say 60' c.c.




Laterals

$Q_L = 2Q_0 = 2(1.106) = 2.21$ cfs

Try 10" dia AC Pipe

D
S
V
Q
F

OK. Use @ min slope
$S = 0.00720$

AE
PJM 5-23-80
Toe Drain

Harquahala FRS

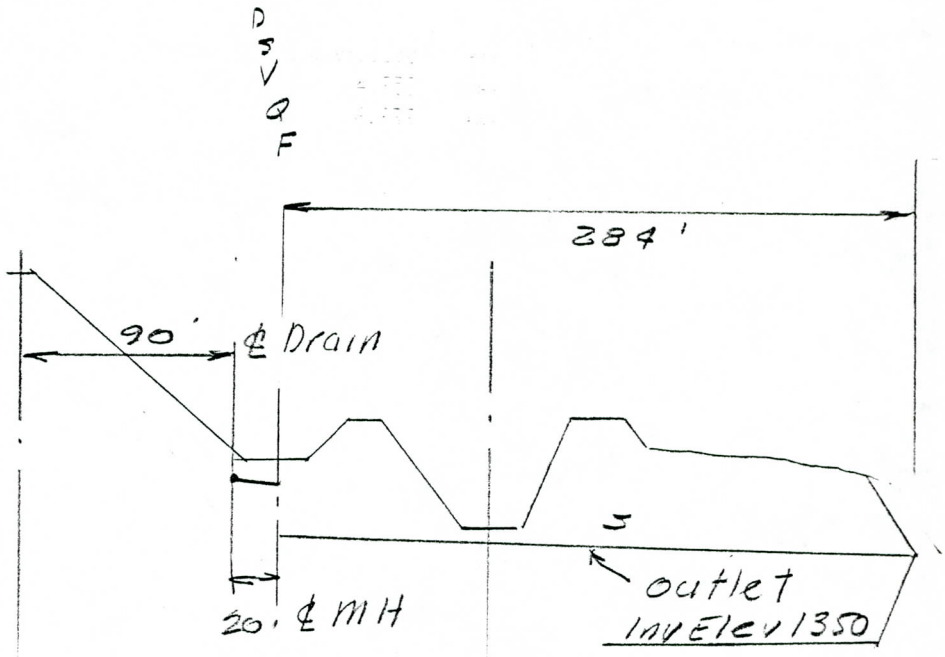
29 32

Collector

Place the MH @ Sta 10+5+00

Qmax - collector
= 3 (2.21) = 6.63 cfs

should be able to use a 16" dia AC pipe collector @ min slope of 0.00535 ft/ft




Assume: max ws in MH = Elev 1370
- MH dia 6'

Full pipe flow

$$Q = A\sqrt{\frac{2gH}{1+K_e+K_pL}}$$

K = 0.5

$$H = \frac{Q^2}{64.4A^2}(1+K_e+K_pL)$$

AZ Harquahala FRS
RJM 5-23-80
Toc Drain

30 32

Try 12" dia RC pipe $n = 0.013$

$A = 0.785$
$K_p = 0.0313$

$$H = \frac{(6.63)^2}{(64.4)(0.785)^2}\left[1.5 + (281)(0.0313)\right]$$

$= 11.40$

WS Elev = 1350 + 1.0 + 11.40
= 1362.4 < max WS = 1370 ok

USE 12" dia RC pipe outlet

For $s = 0.0443$ flow is super-critical and exceeds Q max

D
S
V
Q
F

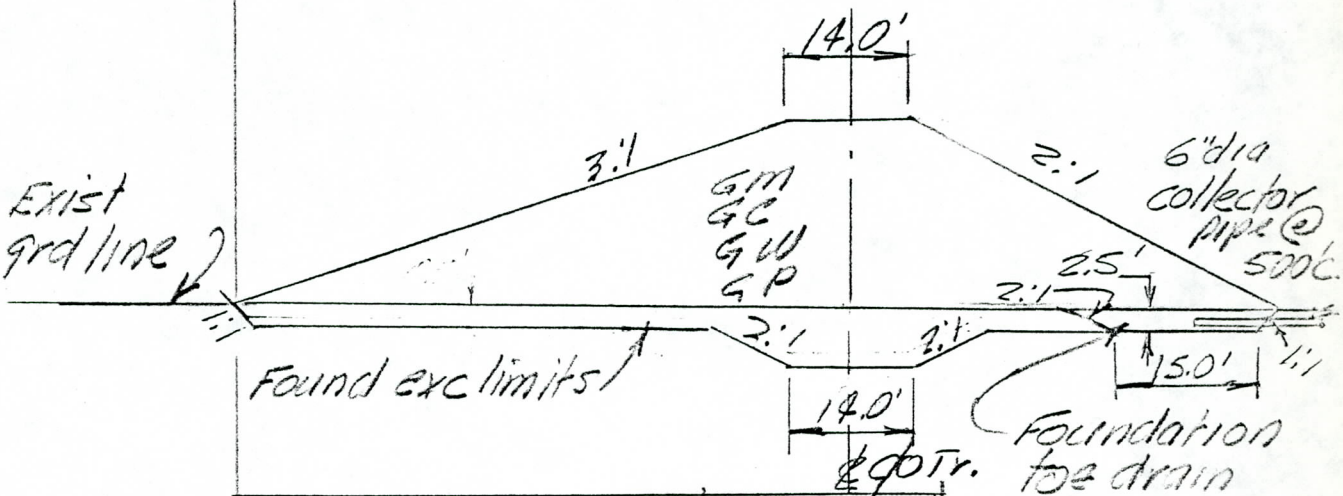
EMBANKMENT - REACH-1

AE Harquahala FRS
RJM 2/25/80
Embankment Design 1 4

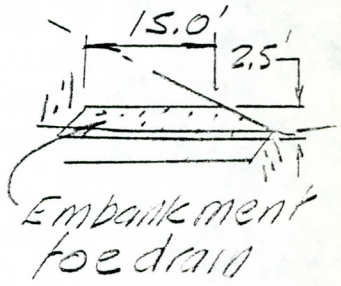
Design an embankment section for Reach 1 (sta 717+00± to sta 1054+20±) by proposing and examining a minimum of three alternatives and selecting one for comparison with Reach 2 choice.

## Alternative 1

### Work Plan Selection




| Station | Drain Type | Length, ' |
|---|---|---|
| 717+00 | | |
| | Embank. | 6,000 |
| 777+00 | | |
| | Found. | 10,000 |
| 877+00 | | |
| | Embank. | 300 |
| 880+00 | | |
| | Found. | 15,800 |
| 1038+00 | | |
| | Embank | 1,600 |
| 1054+00 | | |

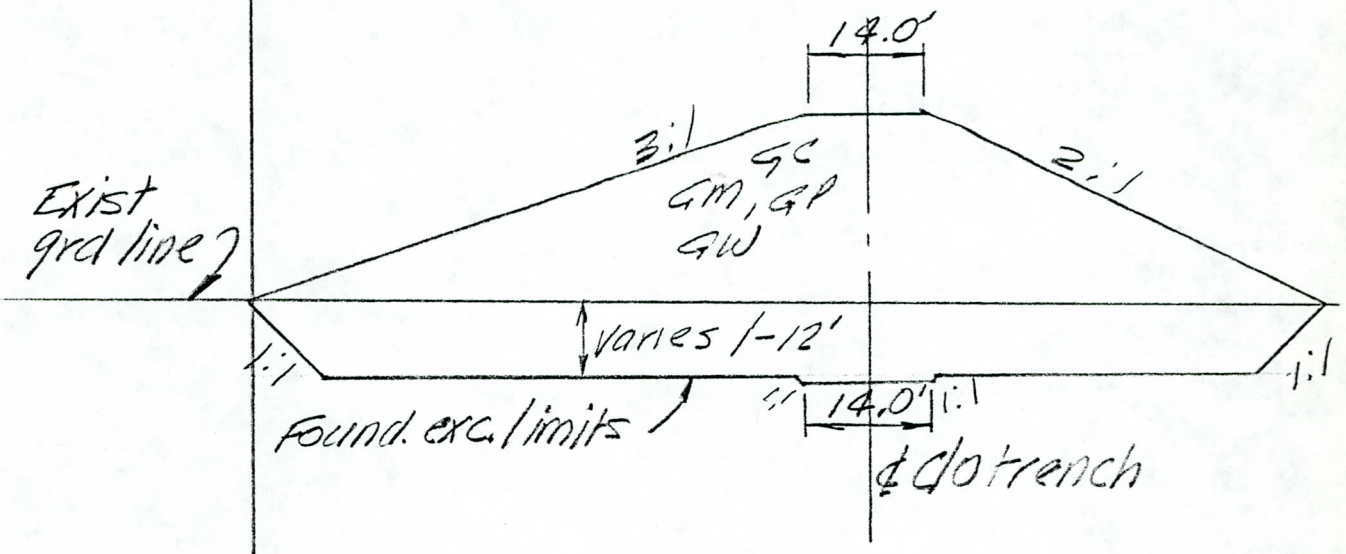


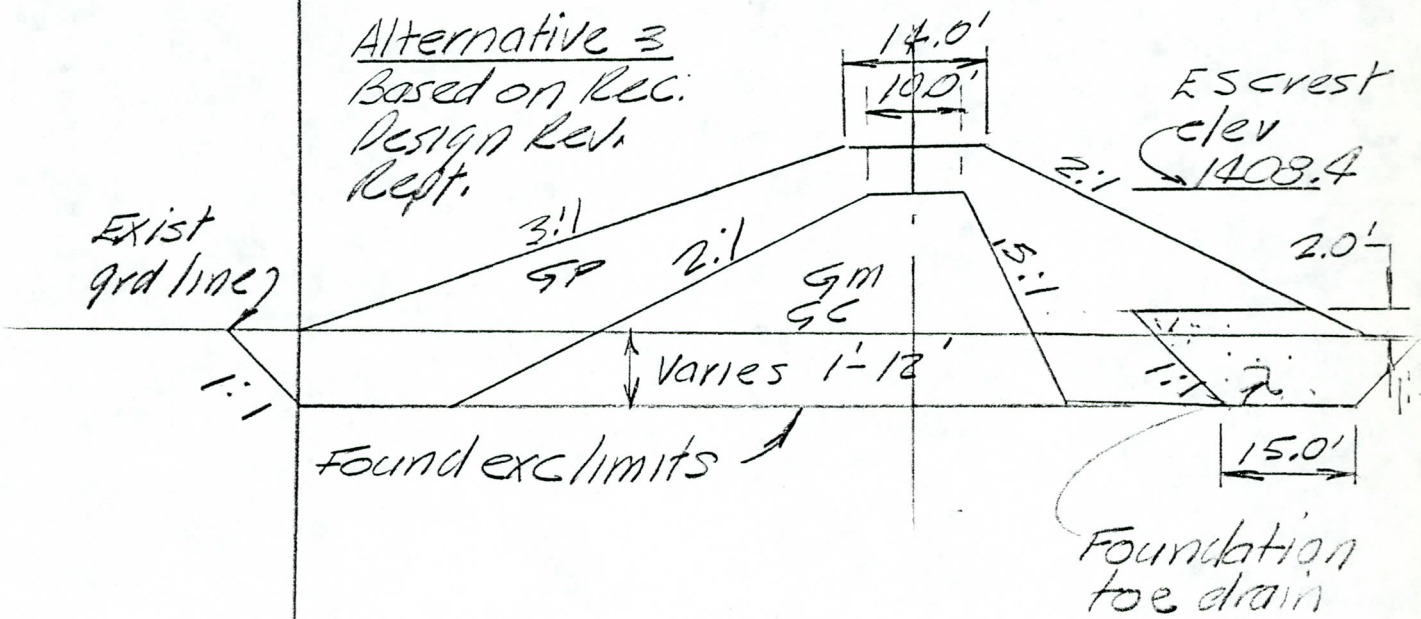
Az Rim 2/25/80 Harquahala FRS

Embankment Design 2 4

Alternative 2 -

Preliminary Design Selection

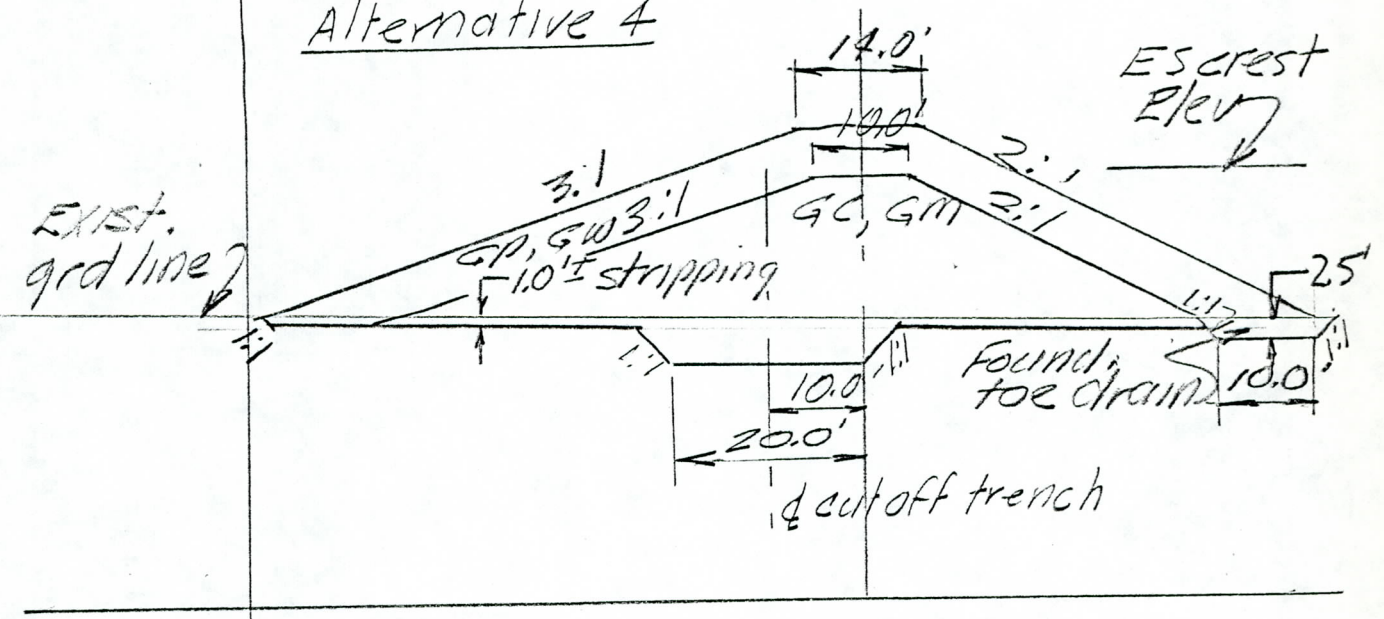


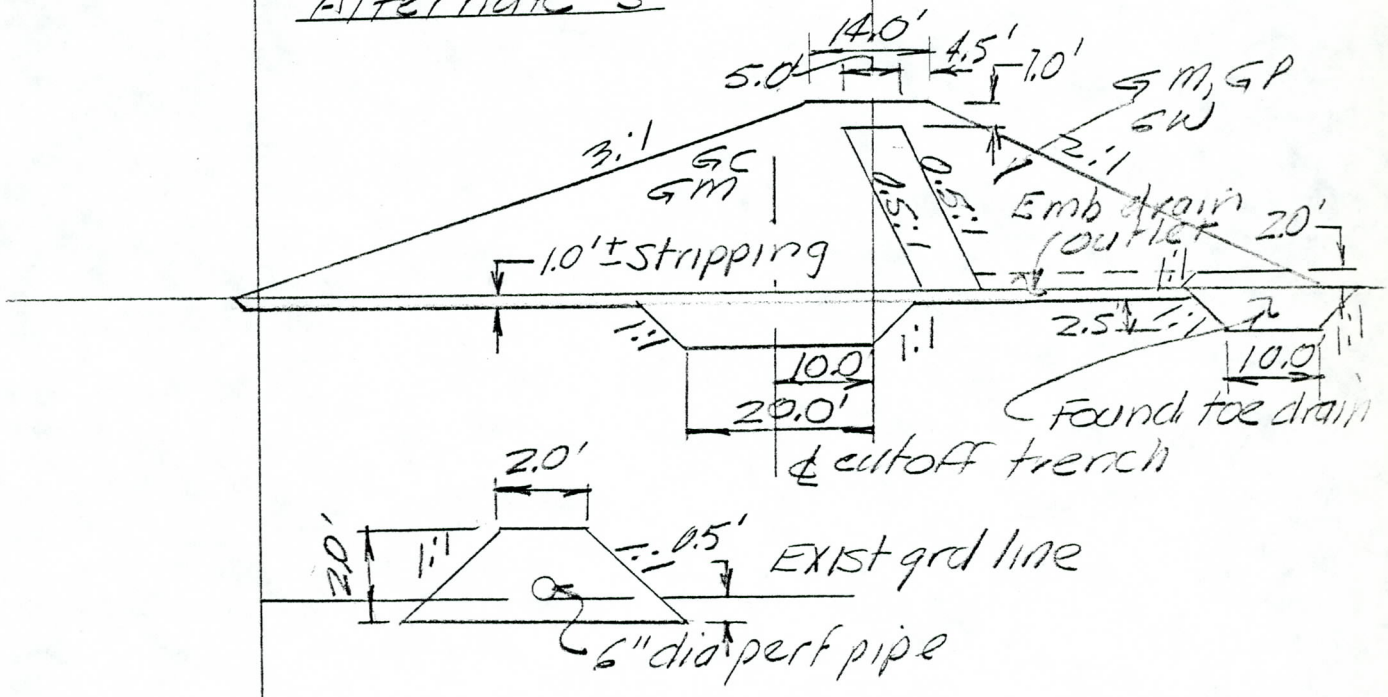
AZ
PJM 2/27/80 Harquahala FRS
Embankment Design

3 4

Alternative 4




Alternate 5

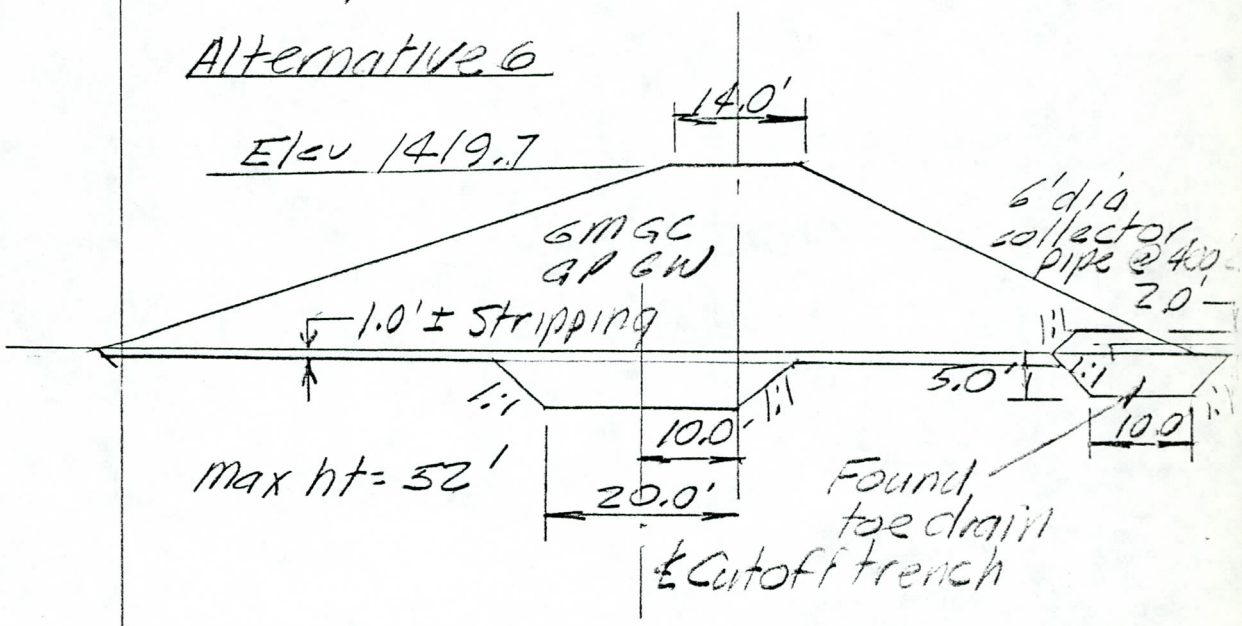






CROSS SECTION
DRAIN OUTLET

AZ Harquahala FRS
RJM 2/27/80
Embankment Design 4 4




Select Alt 6 & review w SCE

FOUNDATION - REACH 2

AZ Harquahala FRS
RJM 5-30-80
Reach 2 Foundation

Conclusions:

1. At loads near 30 psi the axial strain @ failure can be exceeded for depths up to 15 feet or greater
2. Of the 3 samples tested for triaxial shear a non-plastic SM is the weakest, a ~~low~~ moderately plastic SM the strongest. The other sample is an ML
3. There is no apparent relation between % collapse and blow-count.
4. Only SM-ML @ 4.75' dp in TP 77 appears to exceed the tested axial strain failure for low plastic SM or ML of the SM and ML samples plotted @ ≈ 20 psi
5. Maximum settlement calculated @ Sta 603+00 is 1.3 ft.
   a. Residual settlement after 2 mo construction period assuming natural moisture is 1.56'
   b. Residual settlement after 2 mo construction period assuming saturation to 12' depth is 1.39'
6. Maximum settlement calculated @ Sta 522+50 is 1.4 ft
7. Maximum settlement calculated @ Sta 653+00 is 1.2 ft

Az Harquahala FRS
RM 6-9-30
Reach 2 Foundation 2 2

8. The magnitude of the foundation settlement and the incidence of rupture from collapse can be reduced by prewetting the foundation to a depth of approximately 12 feet. However the incidence of rupture from collapse can not be totally eliminated not even with the removal and recompaction of the loose surface material.
9 Prewetting the foundation to a depth of 12 feet should eliminate the incidence of rupture from collapse within this depth
10 Potential for rupture from collapse does appear to exist in the deep foundation.
11 Foundation prewetting to a depth of approximately 12 feet and a surcharge of 1.5 feet should result in a dam safe from overtopping and from extensive settlement cracking. Inspection and maintenance should be provided to observe cracking and dress the dam slopes.
12. Cracking defense is provided in the embankment drain

Az
Rim
6-7-80
Embankment Unit Weights

Harquahala FRS

| Unified Soil Class | TP OR DH # | Depth ft | $\gamma_{dmax}$ pcf | w % | $G_s$ | $w_{sat}$ % | $\gamma_{sat}$ pcf | $\gamma_m$ pcf | .95 $\gamma_{sat}$ pcf | .85 $\gamma_m$ pcf |
|---|---|---|---|---|---|---|---|---|---|---|
| ML | 77 | 12.00 | 120.2 | 12.5 | 2.69 | 14.7 | 137.9 | 135.2 | 131.0 | 128.5 |
| CL-ML | 81 | 7.00 | 119.0 | 13.3 | 2.68 | 15.1 | 137.0 | 134.8 | 130.1 | 128.1 |
| SM | 82 | 5.50 | 124.0 | 11.3 | 2.67* | 12.9 | 140.0 | 138.0 | 133.0 | 131.1 |
| SM | 82 | 8.00 | 121.8 | 11.0 | 2.67* | 13.8 | 138.6 | 135.2 | 131.7 | 128.4 |
| SM | 83 | C.25 | 122.6 | 11.5 | 2.67* | 13.4 | 139.0 | 136.7 | 132.1 | 129.9 |
| SM | 80 | | | | 2.67 | | | | | |

$$w_{sat} = \frac{\gamma_w}{\gamma_d} - \frac{1}{G_s} \qquad \gamma_m = \gamma_d(1+w) \qquad \gamma_{sat} = \gamma_d(1+w_{sat})$$

.95 $\gamma_{m_{AV}}$ = 129.2 pcf

.95 $\gamma_{sat_{AV}}$ = 131.6 pcf

.95 $\gamma_{d_{AV}}$ = 115.4 pcf

* USED TP80 value.

SES/025

AZ Harquahala FRS
RJM 5-29-80
REACH 2 FOUNDATION 1

Plot % COLLAPSE VS SAMPLE DEPTH
FOR 10 psi, 20 psi, 30 psi

10 psi = 1.44 KSF
20 psi = 2.88 KSF
30 psi = 4.32 KSF

| Lab No | TESTPIT OR DRILL HOLE NO. | UNIFIED SOIL CLASS. | DEPTH FT | % COLLAPSE 1.44 KSF | 2.88 KSF | 4.32 KSF |
|---|---|---|---|---|---|---|
| | 70 | SC | 6.5' | 1.3 | 2.1 | 3.2 |
| | 70 | CL | 8.5 | 0.0 | 1.2 | 4.3 |
| | 72 | SC-CL | 8.0 | 0.5 | 0.8 | 1.3 |
| | 72 | CL-CH | 10.0 | 0.4 | 0.5 | 0.6 |
| | 73 | CL | 6.25 | 0.0 | 3.7 | 6.1 |
| | 73 | SC | 8.6 | 1.4 | 3.6 | 5.1 |
| | 75 | CL | 6.35 | 0.4 | 1.5 | 2.7 |
| | 77 | SM-ML | 4.75 | 3.5 | 6.0 | 7.9 |
| | 77 | ML | 12.0 | 0.3 | 1.7 | 3.8 |
| | 80 | ML | 7.0 | 0.4 | 0.6 | 0.9 |
| | 81 | CL-ML | 7.0 | 0.3 | 2.5 | 4.3 |
| | 81 | CL-ML | 9.0 | 1.9 | 3.3 | 4.6 |
| | 81 | SM | 12.0 | 0.4 | 1.6 | 2.7 |
| | 82 | SM | 8.0 | 1.4 | 2.6 | 4.1 |
| | 83 | SM | 6.25 | 0.9 | 0.8 | 0.4 |
| 80W527A | 1601.1 | ML | 7.25 | 0.0 | 0.4 | 0.8 |
| 80W527B | 1601.1 | ML | 7.25 | 0.0 | 0.8 | 1.6 |
| 80W528 | 1601.2 | SC-SM | 13.25 | 0.0 | 0.9 | 1.5 |
| 80W529 | 1601.3 | SM | 26.0 | 0.0 | 1.6 | 3.7 |
| 80W529 | 1601.3 | SM | 26.5 | 0.0 | 1.2 | 1.8 |
| 80W530A | 1601.4 | SM | 34.25 | 0.0 | 0.0 | 0.4 |
| 80W530B | 1601.4 | SM | 34.25 | 0.0 | 0.3 | 1.3 |

AZ Harquahala FRS
RJM 5-29-80
Reach 2 Foundation

| Lab No | Test Pit or Drill Hole No | Unified Soil Class. | Depth Ft | % Collapse 1.44 KSF | 2.88 KSF | 4.32 KSF |
|---|---|---|---|---|---|---|
| 80W531 | 16362 | SM | 11.25 | 0.1 | 1.4 | 2.1 |
| 80W532A | 16323 | ML | 22.25 | 0.0 | 0.0 | 0.3 |
| 80W532B | 16323 | ML | 22.25 | 0.0 | 1.3 | 2.2 |
| 80W533 | 16324 | SC | 26.75 | 0.6 | 1.0 | 1.3 |
| 80W534A | 16325 | ML | 34.5 | 0.0 | 0.1 | 0.4 |
| 80W534B | 16325 | ML | 34.5 | 0.0 | 0.4 | 0.8 |

AZ HARQUAHALA FRS
RM 5-30-80
L-Z FOUNDATION

ML

| Minor Principal Stress PSI | Axial Strain @Failure. % |
|---|---|
| 10 | 5.0 |
| 15 | 2.1 |
| 20 | 2.1 |
| 30 | 2.2 |

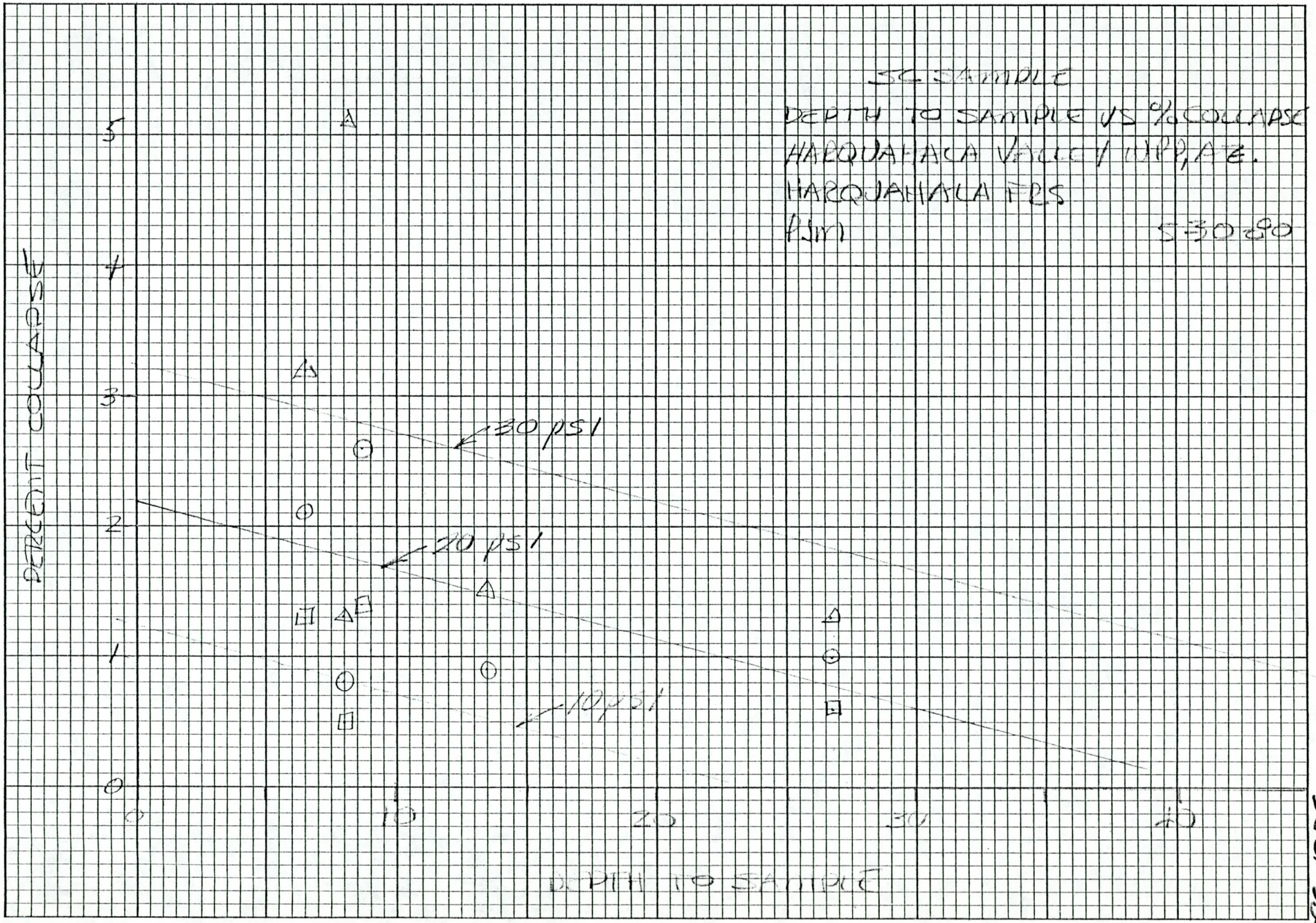
SM MODERATELY PLASTIC

| Minor Principal Stress PSI | Axial Strain@ Failure % |
|---|---|
| 10 | 6.3 |
| 20 | 3.4 |
| 25 | 6.2 |
| 40 | 3.4 |

SM NON-PLASTIC

| Minor Principal Stress PSI | Axial Strain@ Failure % |
|---|---|
| 10 | 1.0 |
| 20 | 1.2 |
| 30 | 0.8 |

K+E 10 X 10 TO THE INCH 46 0702
7 X 10 INCHES MADE IN U.S.A.
KEUFFEL & ESSER CO.



K+E 10 X 10 TO THE INCH 46 0702
7 X 10 INCHES MADE IN U.S.A.
KEUFFEL & ESSER CO.

ML SAMPLE
DEPTH TO SAMPLE VS % COLLAPSE
HARQUAHALA VALLEY UPPER AZ
HARQUAHALA FLS
EJM 5-30-80

PERCENT COLLAPSE

DEPTH TO SAMPLE

low plastic ML 2.1% axial strain @ 20 psi

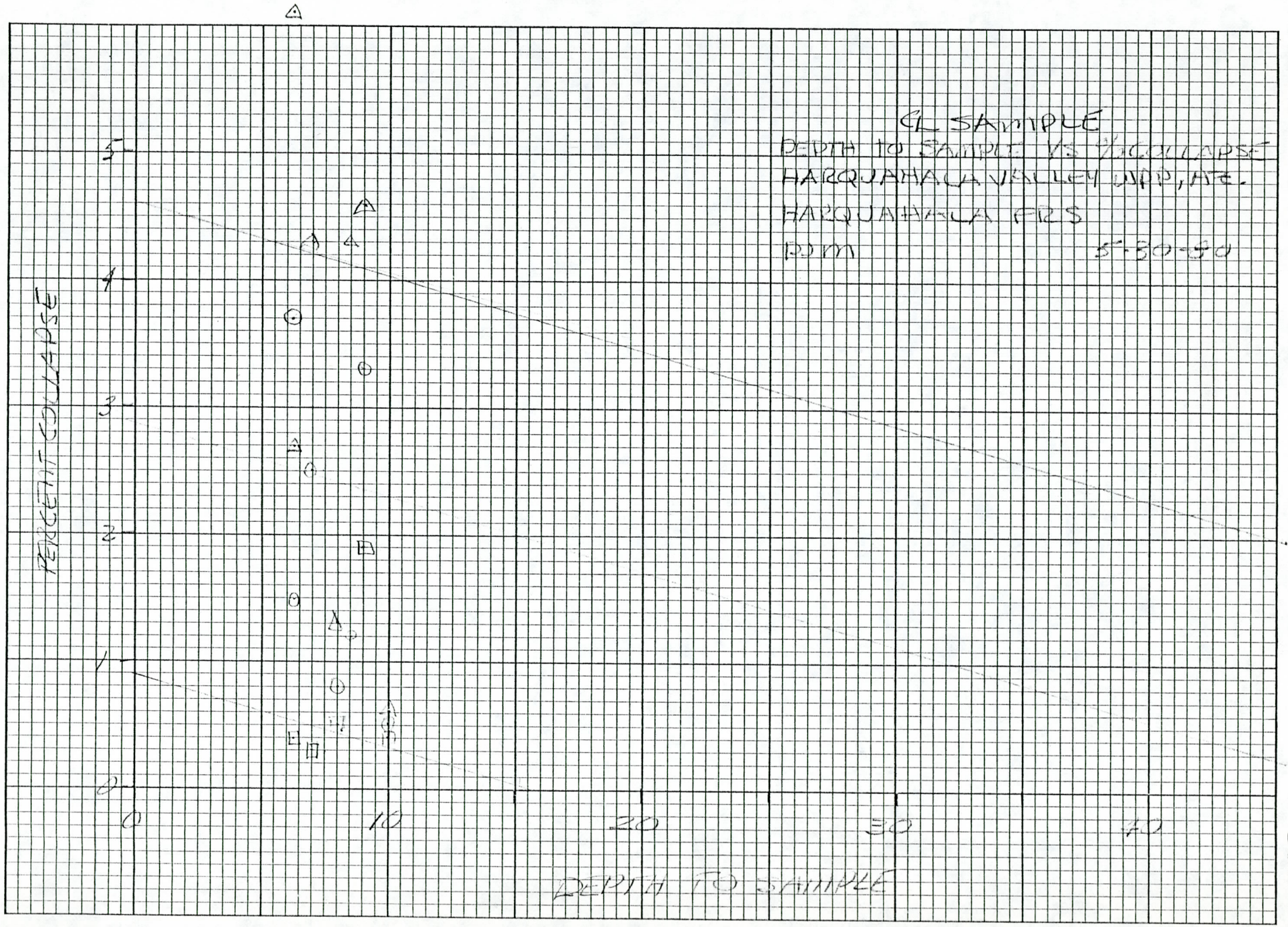
20 psi

5 4 3 2 1

5 4 3 2 1

5 of 25

K+E 10 X 10 TO THE INCH 46 0702
7 X 10 INCHES MADE IN U.S.A.
KEUFFEL & ESSER CO.



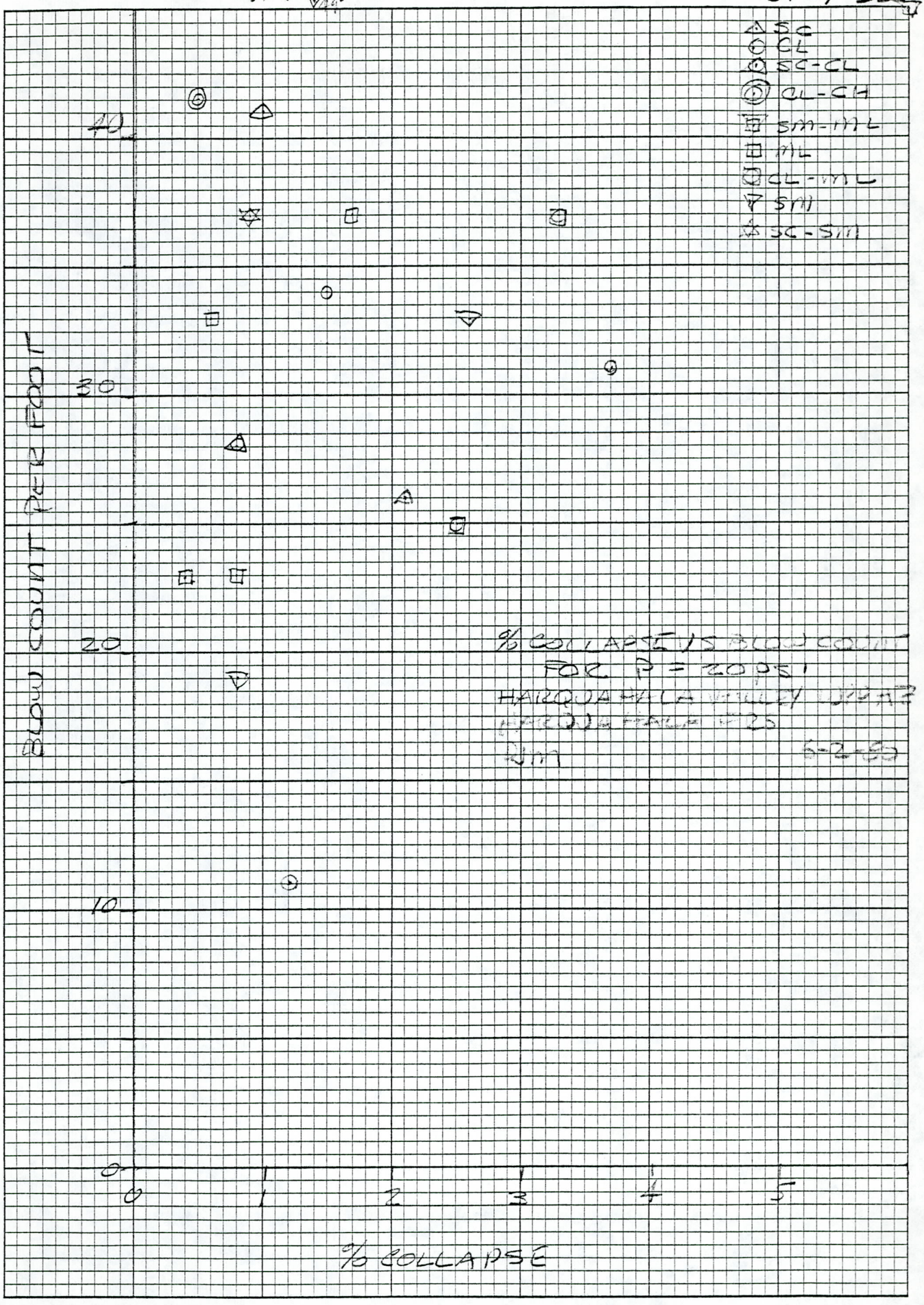

SEE 1085

K&E 10 X 10 TO THE INCH 46 0702
7 X 10 INCHES MADE IN U.S.A.
KEUFFEL & ESSER CO.

Az
RJM 6-2-80

Harquahala FRS

| TPor DH # | Lab No | Unified Soil Class | Depth Ft | % Coll. @ 20 psi | Av Blows/cm per ft | REMARKS |
|---|---|---|---|---|---|---|
| 70 | | SC | 6.5 | 2.1 | 26 | |
| 70 | | CL | 8.5 | 1.2 | 11 | |
| 72 | | SC-CL | 8.0 | 0.8 | 28 | |
| 72 | | CL-CH | 10.0 | 0.5 | 43 | |
| 73 | | CL | 6.25 | 3.7 | 31 | |
| 73 | | SC | 8.6 | 3.6 | 71 | |
| 75 | | CL | 6.35 | 1.5 | 34 | |
| 77 | | SM-ML | 4.75 | 6.0 | 45 | |
| 77 | | ML | 12.0 | 1.7 | 37 | |
| 80 | | ML | 7.0 | 0.6 | 33 | |
| 81 | | CL-ML | 7.0 | 2.5 | 25 | |
| 81 | | CL-ML | 9.0 | 3.3 | 37 | |
| 81 | | SM | 12.0 | 1.6 | 78 | |
| 82 | | SM | 8.0 | 2.6 | 33 | |
| 83 | | SM | 6.25 | 0.8 | 19 | |
| 1601.1 | 80W527A | ML | 7.25 | 0.4 | 23 | TH 18 |
| 1601.1 | 80W527B | ML | 7.25 | 0.8 | 23 | |
| 1601.2 | 80W528 | SC-SM | 13.25 | 0.9 | 37 | |
| 1601.3 | 80W529 | SM | 26.0 | 1.6 | 53 | |
| 1601.3 | 80W529 | SM | 26.5 | 1.2 | 53 | |
| 1601.4 | 80W530A | SM | 34.25 | 0.0 | REF | |
| 1601.4 | 80W530B | SM | 34.25 | 0.3 | " | |
| 1632.2 | 80W531 | SM | 11.25 | 1.4 | 49 | TH 21 |
| 1632.3 | 80W532A | ML | 22.25 | 0.0 | REF | |
| 1632.3 | 80W532B | ML | 22.25 | 1.3 | " | |
| 1632.4 | 80W533 | SC | 26.75 | 1.0 | 41 | |
| 1632.5 | 80W534A | ML | 34.5 | 0.1 | REF | |
| 1632.5 | 80W534B | ML | 34.5 | 0.4 | REF | |




KE 10 X 10 TO THE INCH 46 0702
7 X 10 INCHES MADE IN U.S.A.
KEUFFEL & ESSER CO.

AZ Harquahala FRS
Rm 6-380
Settlement Analysis 1 6

Tabulate values for void ratio and plot the consolidation vs pressure curve for SH#8 Curve Nos 57 & 59

Given:

a. Curve No 57 Pressure vs Consolidation - Percent of initial ht C
TP#77 @ 4.5'-5'
SM-ML
$\gamma_{od}$ = 95.1 pcf
$G_s$ = 2.69*
$w_o$ = 4.2%

Sample trimmed to 2.42" dia x 1.0 HT ring.

* used value for ML @ TP #77 @ 11.5' - 12.5'

b. Curve No 59 Pressure vs. Consolidation - Percent of initial ht. C
TP#77 @ 11.5'-12.5'
ML
$\gamma_{od}$ = 93.8 pcf
$G_s$ = 2.69
$w_o$ = 3.6

Sample trimmed to 2.42" dia x 1.0 HT ring

Az Harquahala FRS
RM 6-3-80
Settlement Analysis 2 6

Solution:

a. Curve No 57

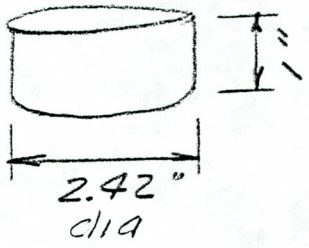
$$e_o = \frac{G_s \gamma_w}{\gamma_d} - 1$$

$$= \frac{2.69(62.4)}{95.1} - 1 = \underline{0.765}$$

$$e = \frac{V}{V_s} - 1$$

where

$$V_s = \frac{V_o}{1+e_o}$$




$$V_o = \frac{\pi (2.42)^2 (1)}{4}$$

$$= 4.6 \text{ cu in} \checkmark$$

$$\therefore V_s = \frac{4.6}{1+0.765} = 2.606 \text{ cu in}$$

check

$$e_o = \frac{4.60}{2.606} - 1 = 0.765 \checkmark$$

Let $t_o$ = initial ht, A = area of sample;
$\therefore V_o = A t_o$

AZ Haryuahala FRS
RM 6-3-80
Settlement Analysis 3 6

@ any ht t

$V = At$

where $t = t_0\left(1 - \frac{C}{100}\right)$

$\therefore V = \frac{\pi(2.42)^2}{4}\left[1.0\left(1 - \frac{C}{100}\right)\right]$

$= 4.60\left(1 - \frac{C}{100}\right)$

& $e = \frac{4.60\left(1 - \frac{C}{100}\right) - 1}{2.606}$

$= \frac{1.765\left(1 - \frac{C}{100}\right) - 1}{}$

| | Load | | Unload | |
|---|---|---|---|---|
| Pressure Kps | Consolidation % | Void Ratio e | Consolidation % | Void Ratio e |
| 0 | 0 | 0.765 | | |
| 0.1 | 0 | 0.765 | 14.0 | 0.518 |
| 0.2 | 0.25 | 0.761 | 14.5 | 0.509 |
| 0.4 | 0.5 | 0.756 | 14.8 | 0.504 |
| 0.7 | 0.7 | 0.753 | 15.1 | 0.498 |
| 1.0 | 0.8 | 0.751 | 15.3 | 0.495 |
| 2.1 | 1.1 | 0.746 | | |
| 2.1 | 5.9 | 0.661 | 15.6 | 0.490 |
| 3.0 | 7.5 | 0.633 | 15.8 | 0.486 |
| 5.0 | 10.0 | 0.589 | 16.4 | 0.476 |
| 10.0 | 13.6 | 0.525 | | |
| 17.3 | 16.6 | 0.472 | | |

Az Harquahala FRS
RM 6-3-80
Settlement Analysis 4 6

b. Curve No 59

$$e_o = \frac{G_s \gamma_w}{\gamma_d} - 1$$

$$= \frac{2.69(62.4)}{93.8} - 1 = 0.790$$

$$e = (1 + e_o)\left(1 - \frac{c}{100}\right) - 1$$

$$= 1.790\left(1 - \frac{c}{100}\right) - 1$$

| Pressure KPS | Consolidation % | Void Ratio e |
|---|---|---|
| 0 | 0 | 0.790 |
| 0.2 | 0.2 | 0.786 |
| 0.4 | 0.4 | 0.783 |
| 0.8 | 0.8 | 0.776 |
| 2.1 | 1.5 | 0.763 |
| 2.1 | 2.5 | 0.745 |
| 4.0 | 5.5 | 0.692 |
| 8.0 | 11.9 | 0.577 |
| 17.1 | 16.0 | 0.504 |

SCS-ENG-128
REV. 4-71

LABORATORY NO. _____

| MATERIALS ESTING REPORT | U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE | CONSOLIDATION TEST |
|---|---|---|

PROJECT and STATE: Harquahala FRS

SAMPLE LOCATION: Sta 603+00

FIELD SAMPLE NO.: TP 77

DEPTH: 4.5'-5'

GEOLOGIC ORIGIN:

TYPE OF SAMPLE: Undisturbed

TESTED AT: SH&B Phx

APPROVED BY:

DATE:

CLASSIFICATION: SM-ML

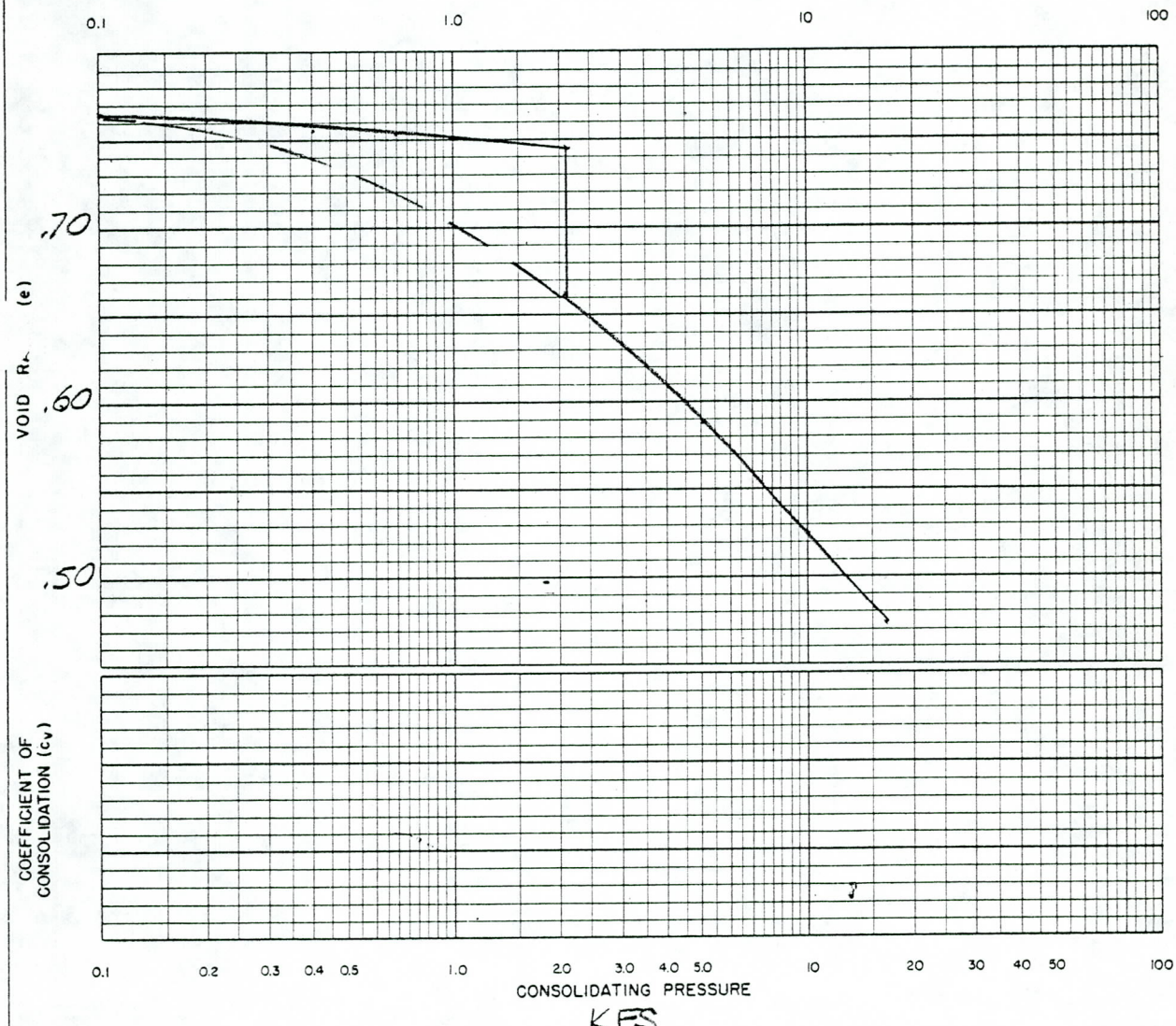
$G_s$ 2.69 LL _____ PI _____

INITIAL DENSITY $\gamma_d$ 95.13

INITIAL VOID RATIO, $e_o$ 0.765

COMPRESSION INDEX, $C_c$ _____

TEST SPECIFICATIONS:




REMARKS

Curve reconstructed from SH&B curve #57

6-3-90 RJM

SCS-ENG-128
REV. 4-71

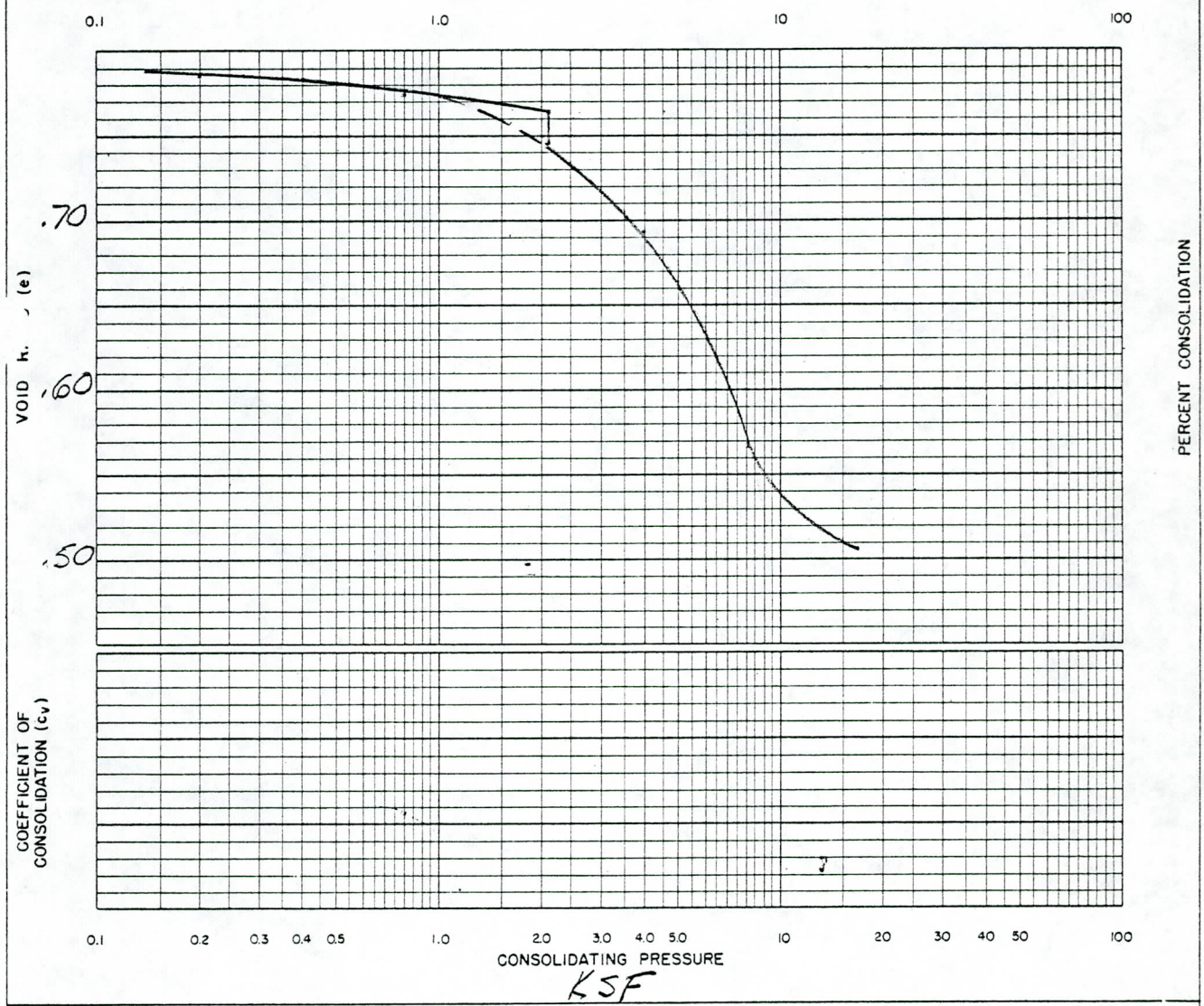
LABORATORY NO. 67 of 335

| MATERIALS TESTING REPORT | U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE | CONSOLIDATION TEST |
|---|---|---|

PROJECT and STATE: Harquahala FRS AZ
SAMPLE LOCATION: Sta 603+00
FIELD SAMPLE NO.: TP 77
DEPTH: 11.5'-12.5'
GEOLOGIC ORIGIN:
TYPE OF SAMPLE: Undisturbed
TESTED AT: SH&B Phx
APPROVED BY:
DATE:

CLASSIFICATION: ML
$G_s$: 2.69 LL: PI:
INITIAL DENSITY $\gamma_d$: 93.75
INITIAL VOID RATIO, $e_o$: 0.790
COMPRESSION INDEX, $C_c$:

TEST SPECIFICATIONS:
Saturated @ 2100 KSF

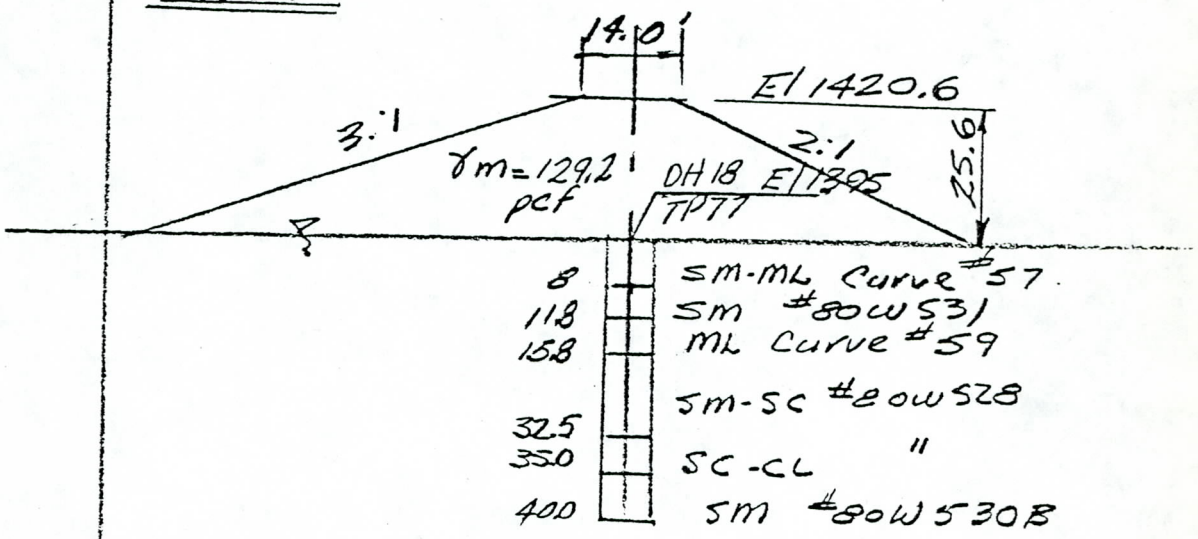



REMARKS
Curve reconstructed from SH&B Curve #57
6-3-80 PJM

AZ Harquahala FRS
PJM 6-3-80
Settlement R-Z



Given:




Sta 603+00

DATA

| Sample | Specific Gravity | Dry Density | Void Ratio |
|---|---|---|---|
| Curve #57 | 2.69 | 95.1 | 0.765 |
| #80W531 | 2.70 | 93.8 | 0.803 |
| Curve #59 | 2.69 | 93.8 | 0.790 |
| #80W528 | 2.69 | 104.4 | 0.616 |
| #80W530B | 2.69 | 95.6 | 0.762 |
| Fill | 2.69 | 115.4 | 0.455 |

DETERMINATION OF OVERBURDEN PRES.

| Depth(d) ft | Δd ft | Density lbs/cu ft | Δpo lbs/sq ft | Total po lbs/sq ft | Tons/sq ft |
|---|---|---|---|---|---|
| 8.0 | 8.0 | 59.7 | 478 | 478 | 0.24 |
| 11.8 | 3.8 | 59.1 | 225 | 703 | 0.35 |
| 15.8 | 4.0 | 58.9 | 236 | 939 | 0.47 |
| 35.0 | 19.2 | 65.6 | 1260 | 2199 | 1.10 |
| 40.0 | 5.0 | 60.1 | 300 | 2499 | 1.25 |

AZ Harquahala Flrs
PJM 6-4-80
Settlement R-2



| Unif. Soil CL | Depth (d) ft | Adj. Depth (d') ft | $\frac{d'}{b}$ | $\frac{\Delta\rho}{\rho}$ | $\Delta\rho$ KSF |
|---|---|---|---|---|---|
| SM-ML | 0 | 0 | 0 | 1.0 | 3.3 |
| SM | 8 | 8 | 0.137 | 0.92 | 3.0 |
| ML | 12 | 14 | 0.241 | 0.84 | 2.7 |
| SM-SC | 16 | 18 | 0.309 | 0.80 | 2.6 |
| SC-CL | 32 | 42 | 0.722 | 0.62 | 2.0 |
| SM | 35 | 45 | 0.773 | 0.59 | 1.9 |
| | 40 | 52 | 0.893 | 0.54 | 1.7 |

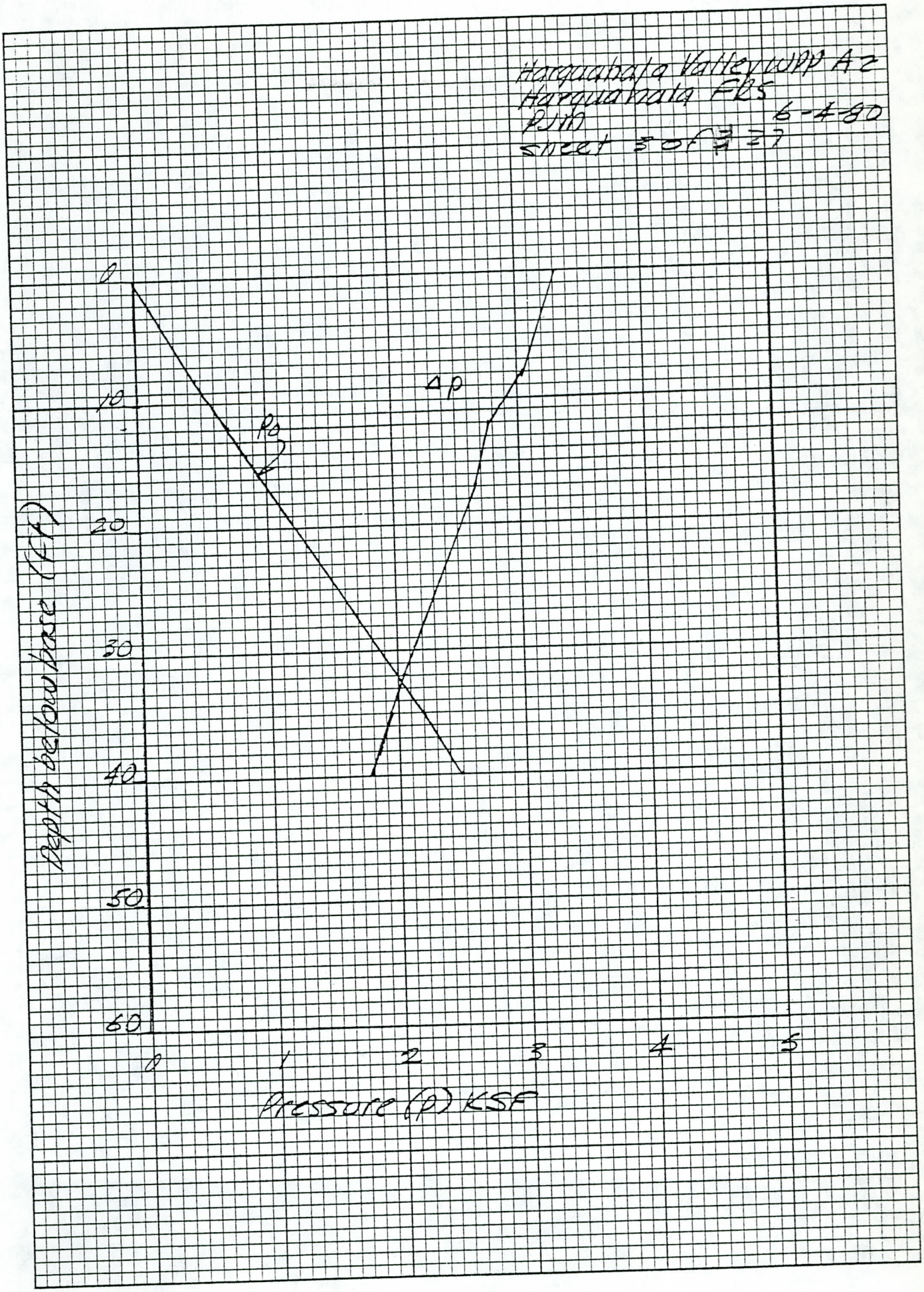
$b = 7 + 2(25.6) = 58.2'$

$\rho = \frac{25.6(1292)}{1000} = 3.31$ KSF

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample | Depth ft | H ft | $\rho_o$ KSF | $\Delta\rho$ KSF | $\rho_o+\Delta\rho$ KSF | $e_o$ | $e_f$ | $e_o - e_f$ | $\frac{1}{1+e_o}$ | $\frac{\Delta e}{1+e_o}$ | S ft |
| 57 | 0-8 | 8 | .21 | 3.19 | 3.40 | .754 | .622 | .132 | 1.754 | .075 | 0.602 |
| 531 | 8-12 | 4 | .56 | 2.90 | 3.46 | .790 | .700 | .090 | 1.790 | .050 | 0.201 |
| 59 | 12-16 | 4 | .82 | 2.72 | 3.54 | .777 | .702 | .075 | 1.777 | .042 | 0.169 |
| 528 | 16-35 | 19 | 1.57 | 2.30 | 3.87 | .577 | .516 | .061 | 1.577 | .039 | 0.735 |
| 5308 | 35-40 | 5 | 2.33 | 1.86 | 4.19 | .740 | .713 | .027 | 1.740 | .016 | 0.078 |

$\Sigma S = 1.785'$ Say $1.8'$

Harquahala Valley WDP AZ
Harquahala FRS
PJM 6-4-80
sheet 5 of 7




K&E 10 X 10 TO THE INCH 46 0702
7 X 10 INCHES MADE IN U.S.A.
KEUFFEL & ESSER CO.

AZ Harquahala FRS
RM 6-5-60
Settlement C-2 4 27

Determine degree of consolidation for samples shown on sheet 1. Comparisons of the e-p curves for samples 77 & 79 with sample 531 show a fairly close correlation. Since no log time consolidation tests were made for samples 77 & 79 the curve for No 531 will be used

The following conditions will be assumed and total residual settlement determined

1. Saturation to 12 depth, natural moisture conditions below 12 ft depth and a two month construction period

2. Natural moisture conditions at all depths during a two month construction period

SCS-ENG-128
REV. 4-71

5 of 27
LABORATORY NO. 72 of 335

| MATERIALS TESTING REPORT | U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE | CONSOLIDATION TEST |
|---|---|---|

PROJECT and STATE: Harquahala FRS
SAMPLE LOCATION: Sta 603+00

FIELD SAMPLE NO.: TP 77
DEPTH: 4.5'-5'
GEOLOGIC ORIGIN:

TYPE OF SAMPLE: Undisturbed
TESTED AT: SH&B Phx
APPROVED BY:
DATE:

CLASSIFICATION: SM-ML

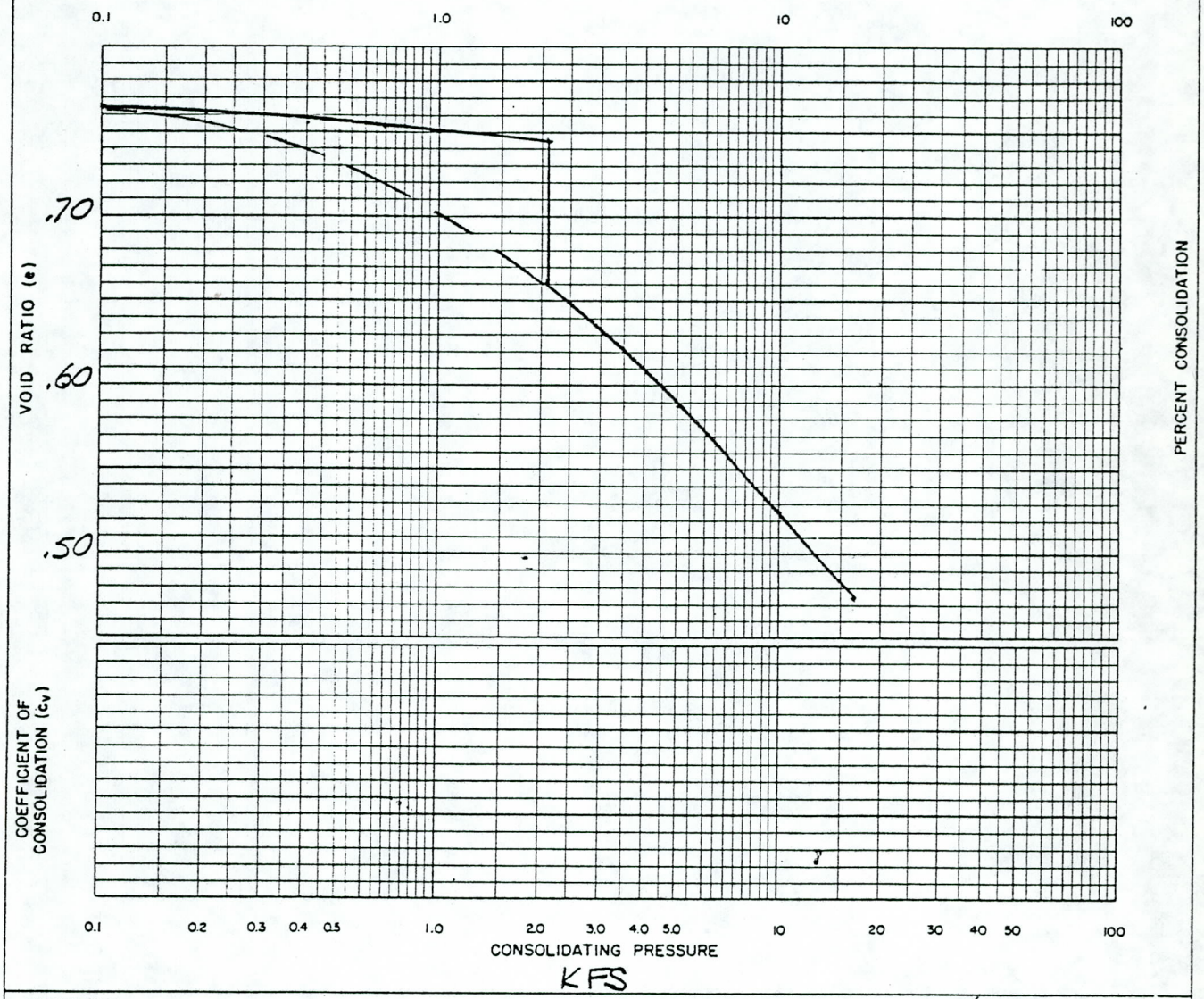
$G_s$ 2.69 LL _____ PI _____

INITIAL DENSITY $\gamma_d$ 95.13

INITIAL VOID RATIO, $e_o$ 0.765

COMPRESSION INDEX, $C_c$ _____

TEST SPECIFICATIONS:




REMARKS

Curve reconstructed from SH&B curve #57

6-3-80 RJM

SCS-ENG-128
REV. 4-71

60 of 27

LABORATORY NO. 73 of 335

| MATERIALS TESTING REPORT | U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE | CONSOLIDATION TEST |
|---|---|---|

| PROJECT and STATE | | SAMPLE LOCATION |
|---|---|---|
| Harquahala FRS AZ | | Sta 603+00 |
| FIELD SAMPLE NO. | DEPTH | GEOLOGIC ORIGIN |
| TP 77 | 11.5'-12.5' | |
| TYPE OF SAMPLE | TESTED AT | APPROVED BY / DATE |
| Undisturbed | SH&B Phx | |

CLASSIFICATION ML

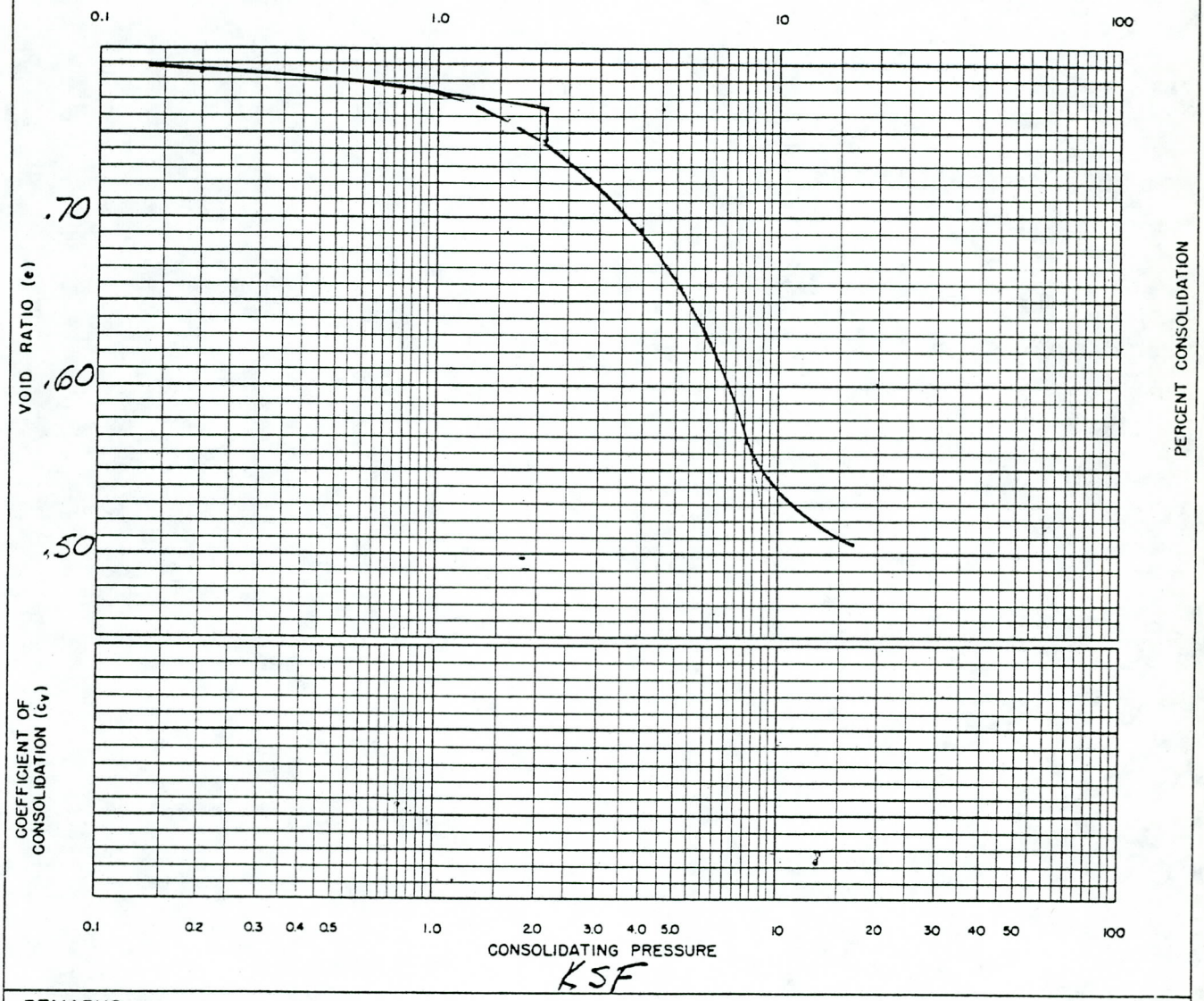
$G_s$ 2.69 LL _____ PI _____

INITIAL DENSITY $\gamma_d$ 93.75

INITIAL VOID RATIO, $e_o$ 0.790

COMPRESSION INDEX, $C_c$ _____

TEST SPECIFICATIONS:
Saturated @ 2100 KSF




REMARKS

Curve reconstructed from SH&B Curve #59
6-3-80 PJM

SCS-ENG-128
REV. 4-71

LABORATORY NO 60W531

7 of 7
74 of 535

# MATERIALS TESTING REPORT | U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE | CONSOLIDATION TEST

PROJECT and STATE: HARQUAHALA VALLEY ARIZONA

SAMPLE LOCATION: STA 632+65

FIELD SAMPLE NO.: 1632.2

DEPTH: 10.0'-12.5'

GEOLOGIC ORIGIN:

TYPE OF SAMPLE: UNDISTURBED

TESTED AT: SML-LINCOLN

APPROVED BY:

DATE:

CLASSIFICATION SM

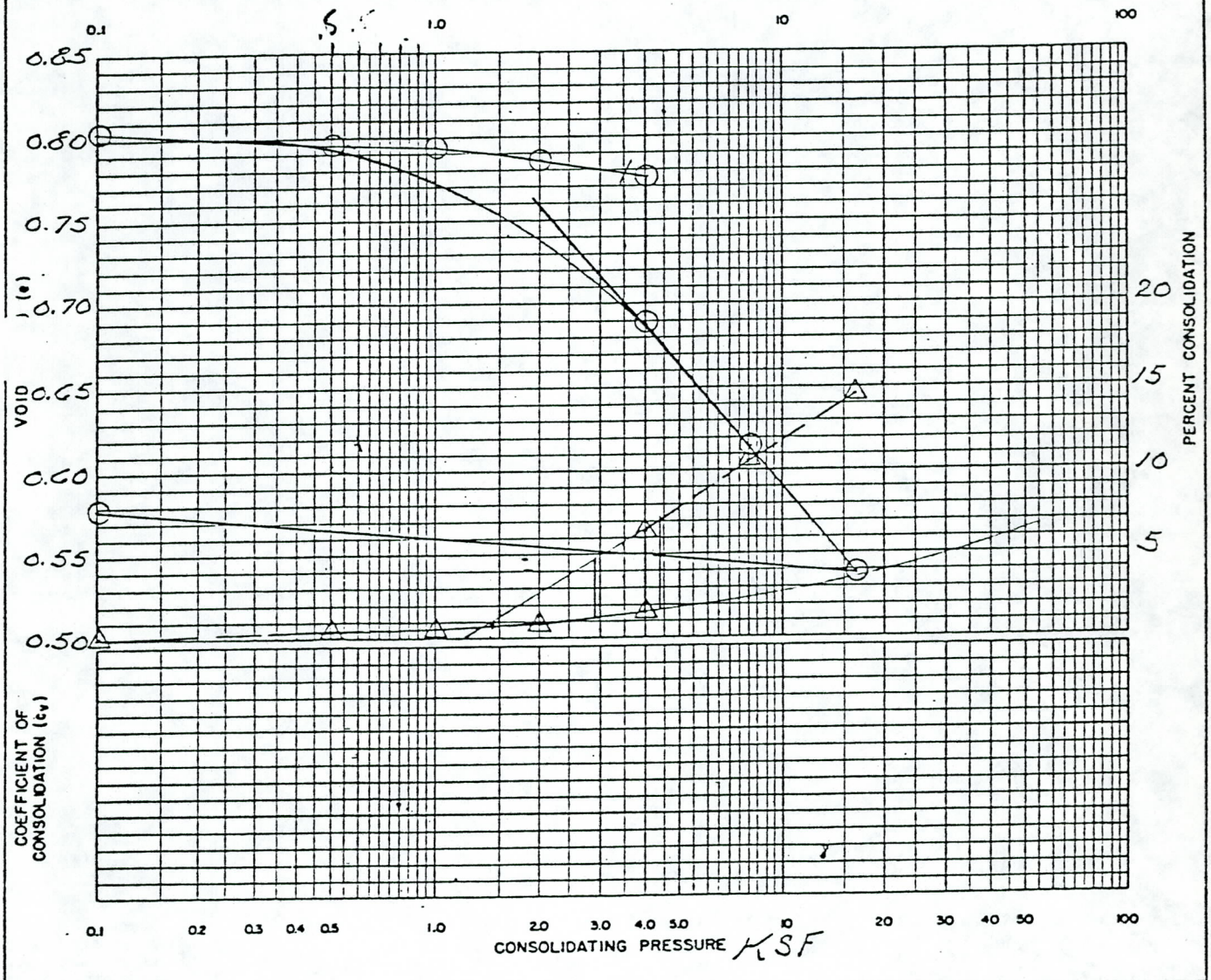
$G_s$ 2.70 LL 36 PI 9

INITIAL DENSITY $\gamma_d$ 1.50 g/cc

INITIAL VOID RATIO, $e_o$ 0.8027

COMPRESSION INDEX, $C_c$

TEST SPECIFICATIONS:
Saturated at 4000 PSF




REMARKS

Water Content of specimen when Trimmed = 8.7%

Water Content of specimen at Start of Test = 5.0%

AZ Harquahala FRS
PJM 6-5-80
Settlement R-2



Degree of consolidation ~~8~~ 12 ft
2 mo construction period

1. $H_f = ~~4~~ 12$
2. $H_e = 1.25$
3. Case 1, Fig 14-12 Applies
   From Table 14-3
   $t_c = \frac{~~1.69~~}{.52}(4)(1.25) = ~~23.4~~\ 2.6 \text{ min}$
   $= ~~1410~~\ 156 \text{ sec}$
4. From Log time Consolidation Curve for Sample 531

| Pres (ksf) | dial reading (in) @ 1,410 sec | dial reading (in) @ 86400 sec |
|---|---|---|
| 0.5 | 0.3975 | 0.3970 |
| 1.0 | 0.3955 | 0.3950 |
| 2.0 | 0.3920 | 0.3910 |
| 4.0 | 0.3870 | 0.3850 |
| 4.0* | 0.~~3460~~,3500 | 0.3370 |
| 8.0* | 0.~~3070~~,3120 | 0.2950 |
| 16.0* | 0.~~2630~~,2700 | 0.2530 |

*Saturated

5. Compute accumulative percent consolidation and prepare table

$$\frac{(\text{dial before new load applied}) - (\text{dial @ 1410 sec after new load appl})}{(\text{dial at start of test}) - (\text{dial at end of test})}$$

Table 14-3. Laboratory time equivalents for various construction time periods (based on laboratory specimen thickness of 1.0 inch)

| Thickness of Field Stratum, $H_f$ (ft.) | Construction Time, $t_f$ | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Two Months | | Four Months | | Six Months | | Eight Months | | Ten Months | | Twelve Months | |
| | $t_\ell$ (min.) | $\sqrt{t_\ell}$ | $t_\ell$ (min.) | $\sqrt{t_\ell}$ | $t_\ell$ (min.) | $\sqrt{t_\ell}$ | $t_\ell$ (min.) | $\sqrt{t_\ell}$ | $t_\ell$ (min.) | $\sqrt{t_\ell}$ | $t_\ell$ (min.) | $\sqrt{t_\ell}$ |
| 2 | 18.75 | 4.32 | 37.50 | 6.12 | 56.25 | 7.50 | 75.00 | 8.66 | 93.75 | 9.68 | 112.5 | 10.62 |
| 4 | 4.69 | 2.16 | 9.38 | 3.06 | 14.06 | 3.75 | 18.75 | 4.32 | 23.44 | 4.83 | 28.12 | 5.31 |
| 6 | 2.08 | 1.44 | 4.17 | 2.04 | 6.25 | 2.50 | 8.33 | 2.88 | 10.42 | 3.23 | 12.50 | 3.54 |
| 8 | 1.17 | 1.08 | 2.34 | 1.53 | 3.52 | 1.86 | 4.69 | 2.16 | 5.86 | 2.42 | 7.03 | 2.66 |
| 10 | 0.75 | 0.87 | 1.50 | 1.22 | 2.25 | 1.50 | 3.00 | 1.73 | 3.75 | 1.94 | 4.50 | 2.12 |
| 12 | 0.52 | 0.72 | 1.04 | 1.02 | 1.56 | 1.25 | 2.08 | 1.44 | 2.60 | 1.61 | 3.12 | 1.76 |
| 14 | 0.38 | 0.62 | 0.76 | 0.86 | 1.15 | 1.07 | 1.53 | 1.24 | 1.91 | 1.38 | 2.30 | 1.51 |
| 16 | 0.29 | 0.54 | 0.58 | 0.76 | 0.88 | 0.94 | 1.17 | 1.05 | 1.46 | 1.21 | 1.76 | 1.32 |
| 18 | 0.23 | 0.48 | 0.46 | 0.68 | 0.69 | 0.83 | 0.92 | 0.96 | 1.16 | 1.07 | 1.39 | 1.18 |
| 20 | 0.19 | 0.43 | 0.38 | 0.61 | 0.56 | 0.75 | 0.75 | 0.87 | 0.94 | 0.97 | 1.12 | 1.06 |
| 22 | 0.15 | 0.39 | 0.31 | 0.56 | 0.46 | 0.58 | 0.62 | 0.78 | 0.77 | 0.88 | 0.93 | 0.96 |
| 24 | 0.13 | 0.36 | 0.26 | 0.51 | 0.39 | 0.62 | 0.52 | 0.72 | 0.65 | 0.81 | 0.78 | 0.88 |
| 26 | 0.11 | 0.33 | 0.22 | 0.47 | 0.33 | 0.58 | 0.44 | 0.66 | 0.55 | 0.74 | 0.66 | 0.82 |
| 28 | 0.10 | 0.32 | 0.19 | 0.44 | 0.28 | 0.54 | 0.38 | 0.62 | 0.48 | 0.69 | 0.57 | 0.76 |
| 30 | 0.08 | 0.29 | 0.17 | 0.41 | 0.25 | 0.50 | 0.33 | 0.58 | 0.42 | 0.65 | 0.50 | 0.71 |
| 32 | 0.07 | 0.27 | 0.15 | 0.38 | 0.22 | 0.47 | 0.29 | 0.54 | 0.37 | 0.61 | 0.44 | 0.66 |
| 34 | 0.06 | 0.25 | 0.13 | 0.36 | 0.19 | 0.44 | 0.26 | 0.51 | 0.32 | 0.57 | 0.39 | 0.62 |
| 36 | 0.06 | 0.24 | 0.12 | 0.34 | 0.17 | 0.42 | 0.23 | 0.48 | 0.29 | 0.54 | 0.35 | 0.59 |
| 38 | 0.05 | 0.23 | 0.10 | 0.32 | 0.16 | 0.40 | 0.21 | 0.46 | 0.26 | 0.51 | 0.31 | 0.56 |
| 40 | 0.05 | 0.22 | 0.09 | 0.30 | 0.14 | 0.37 | 0.19 | 0.43 | 0.23 | 0.48 | 0.28 | 0.53 |

Notes:
1. For laboratory two-way drainage and field one-way drainage (Case 2), use table values.
2. For laboratory two-way drainage and field two-way drainage (Case 1), use 4 times table values.
3. For laboratory one-way drainage and field two-way drainage (Case 3), use 16 times table values.
4. For laboratory one-way drainage and field one-way drainage (Case 4), use 4 times table values.
5. For laboratory specimen thickness other than 1.0 inch, multiply table values by (specimen thickness in inches)$^2$.

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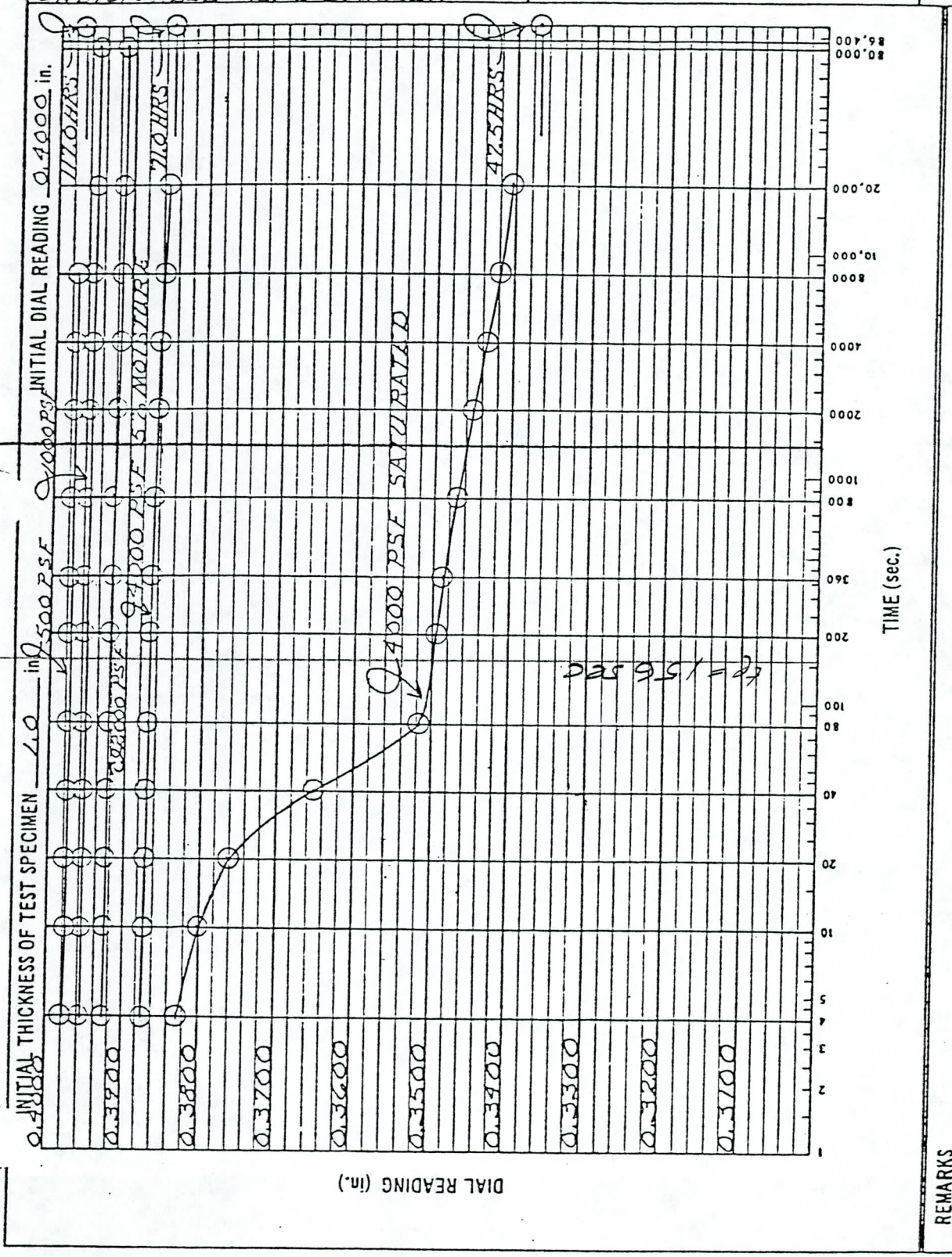
Rev. 5-72

10 OF 27
778 F 336
LABORATORY NO. 80W53

| MATERIALS TESTING REPORT | U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE | LOG TIME CONSOLIDATION |
|---|---|---|

| PROJECT and STATE | | SAMPLE LOCATION |
|---|---|---|
| HEROIC HALA VALLEY ARIZONA | | STA C32+65 |
| FIELD SAMPLE NO. | DEPTH | GEOLOGIC ORIGIN |
| 1632.2 | 10.0'-12.5' | |
| TYPE OF SAMPLE | TESTED AT | APPROVED BY / DATE |
| UNDISTURBED | SML-LINCOLN | |




REMARKS

SCS-ENG-128A
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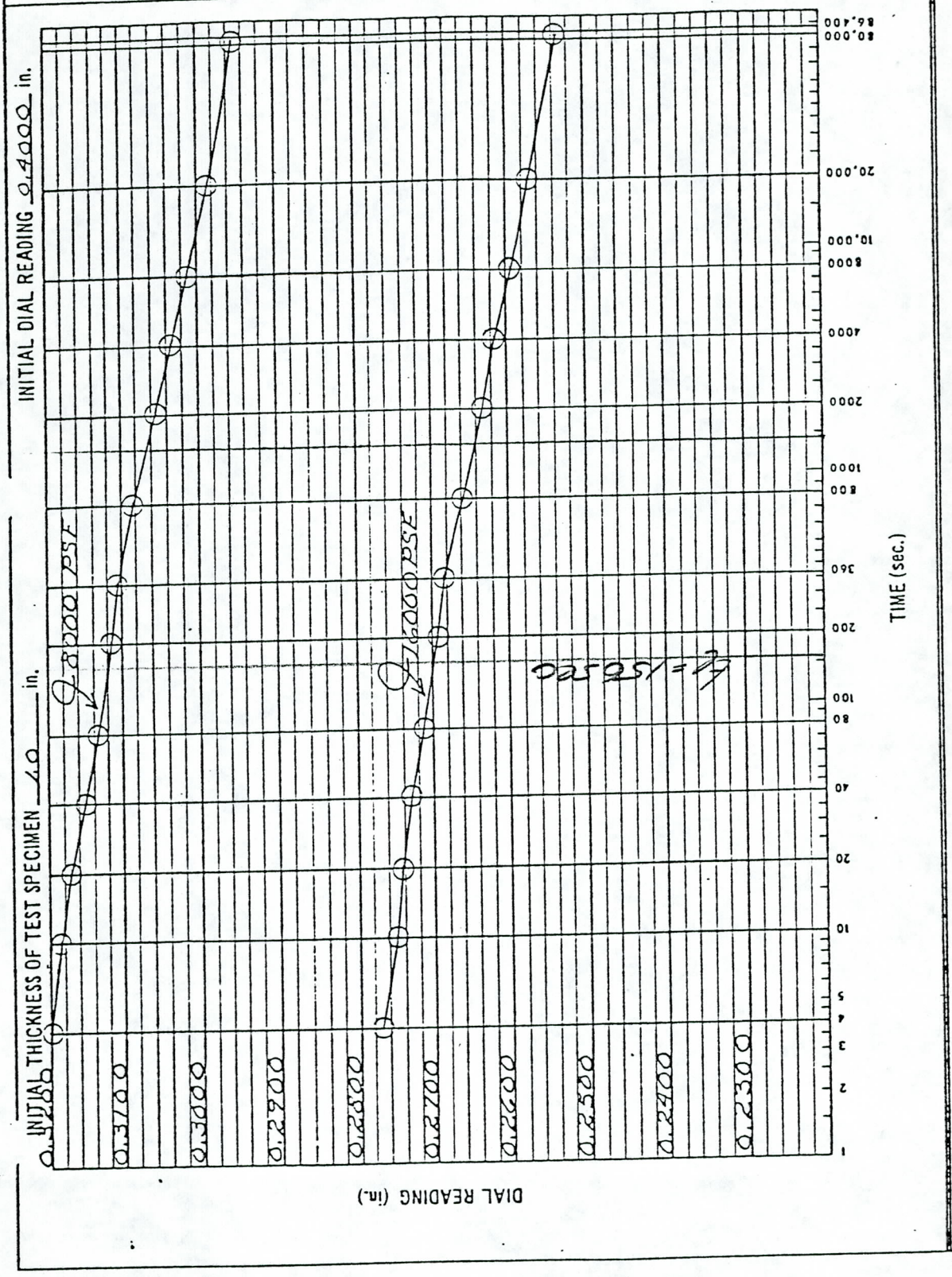
LABORATORY NO. 80W531

| MATERIALS TESTING REPORT | U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE | LOG TIME CONSOLIDATION 80 of 335 |
|---|---|---|

| PROJECT and STATE | | SAMPLE LOCATION |
|---|---|---|
| HARQUAHALA VALLEY ARIZONA | | STA 632+65 |
| FIELD SAMPLE NO. | DEPTH 10.0'-12.5' | GEOLOGIC ORIGIN |
| TYPE OF SAMPLE | TESTED AT SML-LINCOLN | APPROVED BY / DATE |




REMARKS

Az Harquahala FRS
PJM 6-5-86



| Pressure (KSF) | Computation | Incr. Consol. (%) | Acc Cons (% |
|---|---|---|---|
| 0.5 | $\frac{0.4008 - 0.3975}{0.4000 - 0.2530} = \frac{0.0025}{0.1470} \times 100$ | 1.7 | 1.71 |
| 1.0 | $\frac{0.3970 - 0.3955}{0.4000 - 0.2530} = \frac{0.0015}{0.1470} \times 100$ | 1.0 | 2.72 |
| 2.0 | $\frac{0.3950 - 0.3920}{0.4000 - 0.2530} = \frac{0.0030}{0.1470} \times 100$ | 2.0 | 4.74 |
| 4.0 | $\frac{0.3910 - 0.3880}{0.4000 - 0.2530} = \frac{.0040}{0.1470} \times 100$ | 2.7 ~~3.4~~ | 7.48 |
| 4.0* | $\frac{0.3850 - 0.3460}{0.4000 - 0.2530} = \frac{.0350}{0.1470} \times 100$ | 23.8 ~~26.5~~ | 31.2 ~~34~~ |
| 8.0* | $\frac{0.3370 - 0.3070}{0.4000 - 0.2530} = \frac{.0250}{0.1470} \times 100$ | 17.0 ~~20.4~~ | 48.2 55. |
| 16.0* | $\frac{0.2950 - 0.2630}{0.4000 - 0.2530} = \frac{.0250}{0.1470} \times 100$ | 17.0 ~~20.6~~ | 65.2 ~~83~~ |

6 Plot accumulative percent consolidation vs pressure

For $(p + \Delta p) = 3.46$ KSF

@ nat'l moisture $S = 3,075(.803)(.201) = 0.060$ ~~0.047~~
residual settlement = ~~0.186~~ 0.743

@ sat. moisture $S = 2.29(.803)(.201) = 0.233$ ~~0.063~~
residual settlement = ~~0.138~~
0.570

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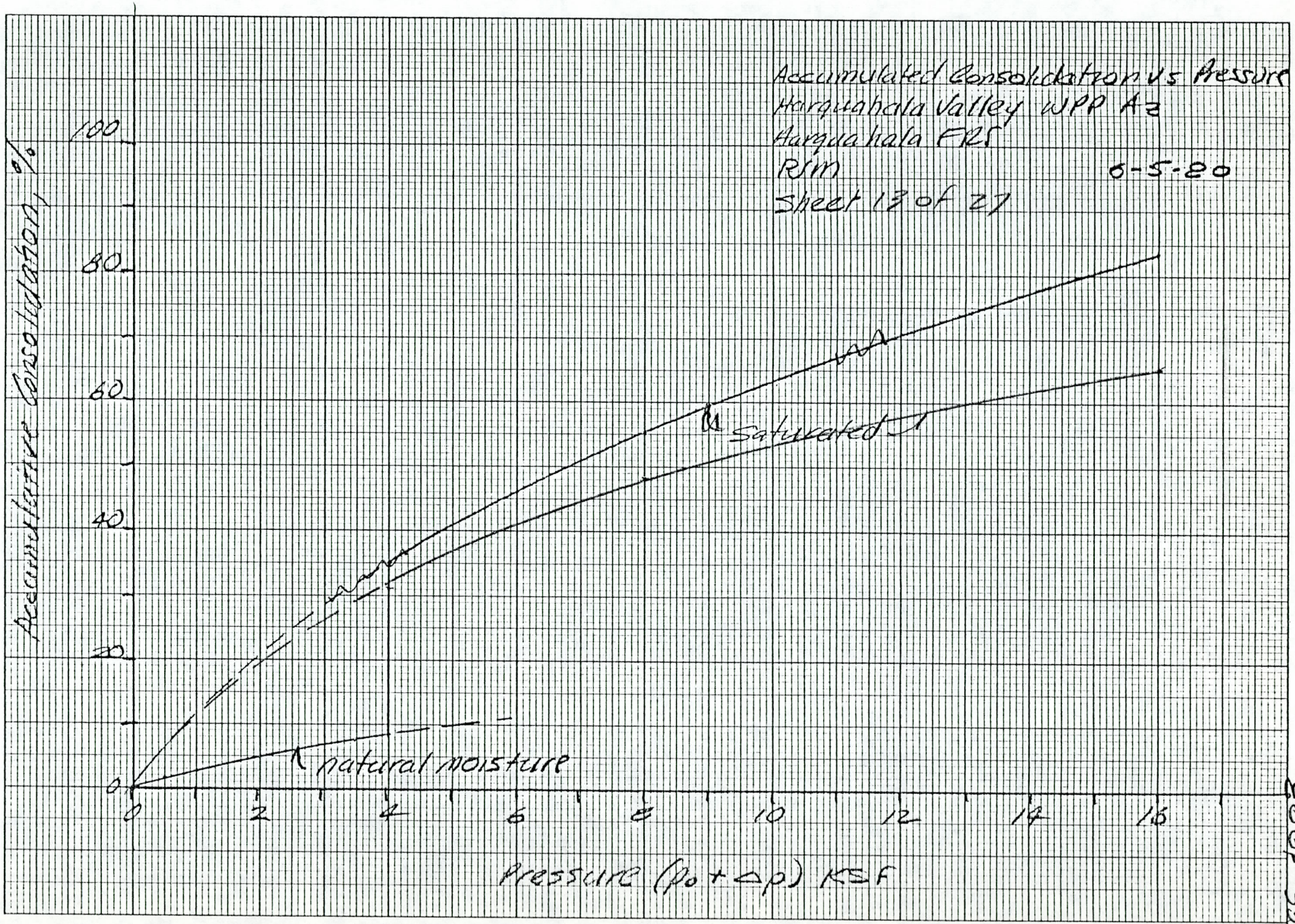
Accumulated Consolidation vs Pressure
Harquahala Valley WPP A-2
Harquahala FRS
RSM 6-5-80
Sheet 13 of 27



Az Harquahala FRS
RM 65-80
Settlement R-7

14 x 20 of 27

Degree of consolidation 12-16 ft
2 mo construction period
1. $H_f = 4'$
2. $H_e = 1.25$
3. Case 1, Fig 14-12 Applies
From Table 14-3
$t_e = 4.69(4)(1.25) = 23.4$ min
$= 1410$ sec
4. From Log time Consolidation curve for sample 531 see accumulative percent consolidation v pressure for 0 - 12 ft

$(\rho + \Delta\rho) = 3.54$

5. @ natl moisture $S = .079(0.169) = 0.0$
residual settlemt = 0.150'

~~@ saturated cond. $S = .321(0.169) = 0.$~~
~~residual settlemt = 0.115~~

---

Degree of consolidation 16-35'
2 mo construction period
1. $H_f = 19'$
2. $H_e = 1.25$
3. Case 1, Fig 14-12 Applies
From Table 14-3
$t_e = 0.21(4)(1.25) = 1.05$ min
$= 63$ sec
4. From Log Time Consolidation curve for sample 528

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REV. 4-71

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LABORATORY NO 80W528
820 of 830

| MATERIALS ESTING REPORT | U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE | CONSOLIDATION TEST |
|---|---|---|

| PROJECT and STATE | | SAMPLE LOCATION |
|---|---|---|
| HARQUAHALA VALLEY ARIZONA | | STA 601+25 |
| FIELD SAMPLE NO. 1601.2 | DEPTH 12.0'-14.5' | GEOLOGIC ORIGIN |
| TYPE OF SAMPLE UNDISTURBED | TESTED AT SML-LINCOLN | APPROVED BY / DATE |

CLASSIFICATION SC or SM

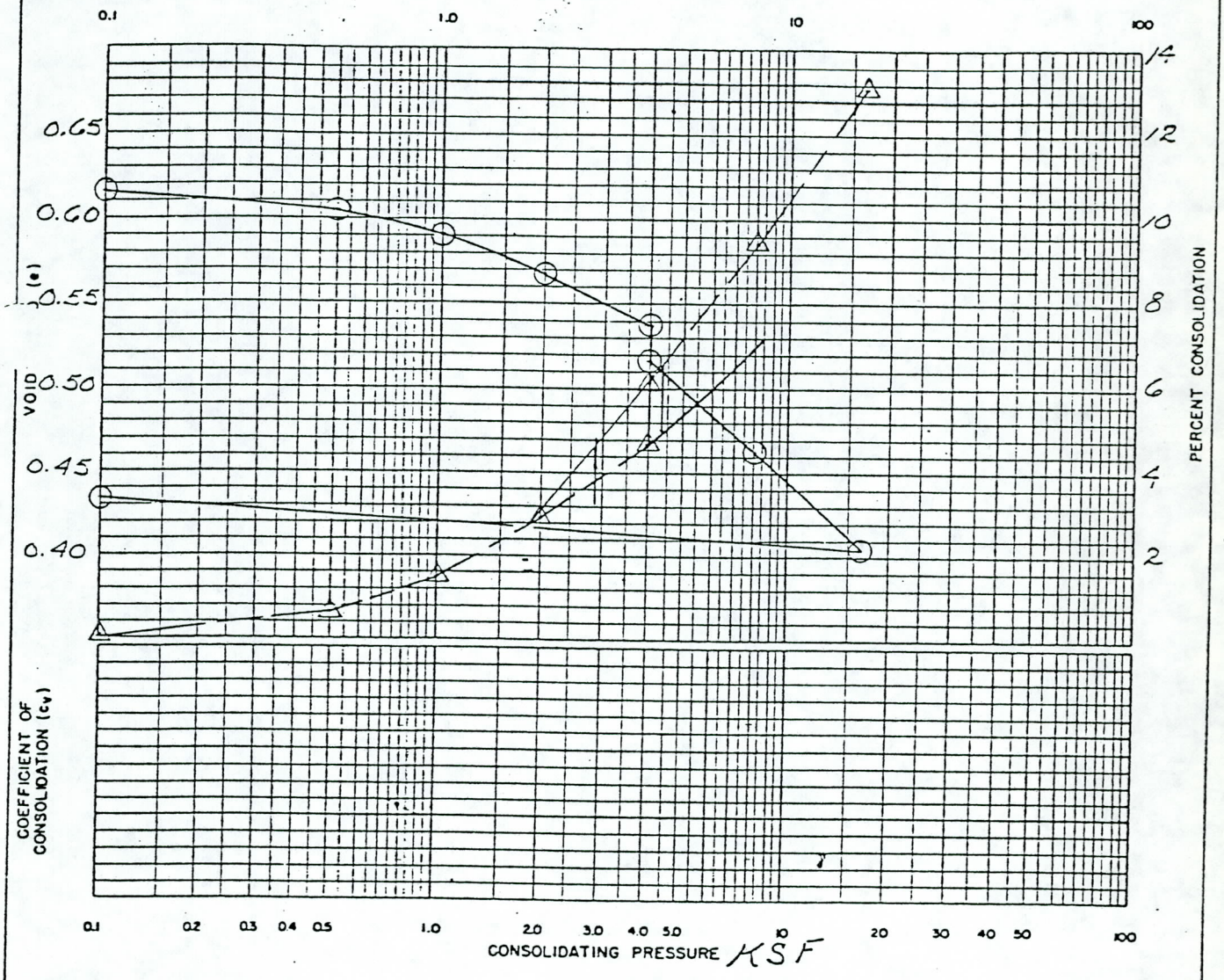
$G_s$ 2.69 LL 31 PI 8

INITIAL DENSITY $\gamma_d$ 1.67 g/cc

INITIAL VOID RATIO, $e_0$ 0.6155

COMPRESSION INDEX, $C_c$

TEST SPECIFICATIONS:
Saturated at 4000 PSF




REMARKS Water Content of the Specimen when Trimmed = 13.2%
Water Content of the Specimen at the Start of Test = 5.0%

SCS-ENG-128A
Rev. 5-72

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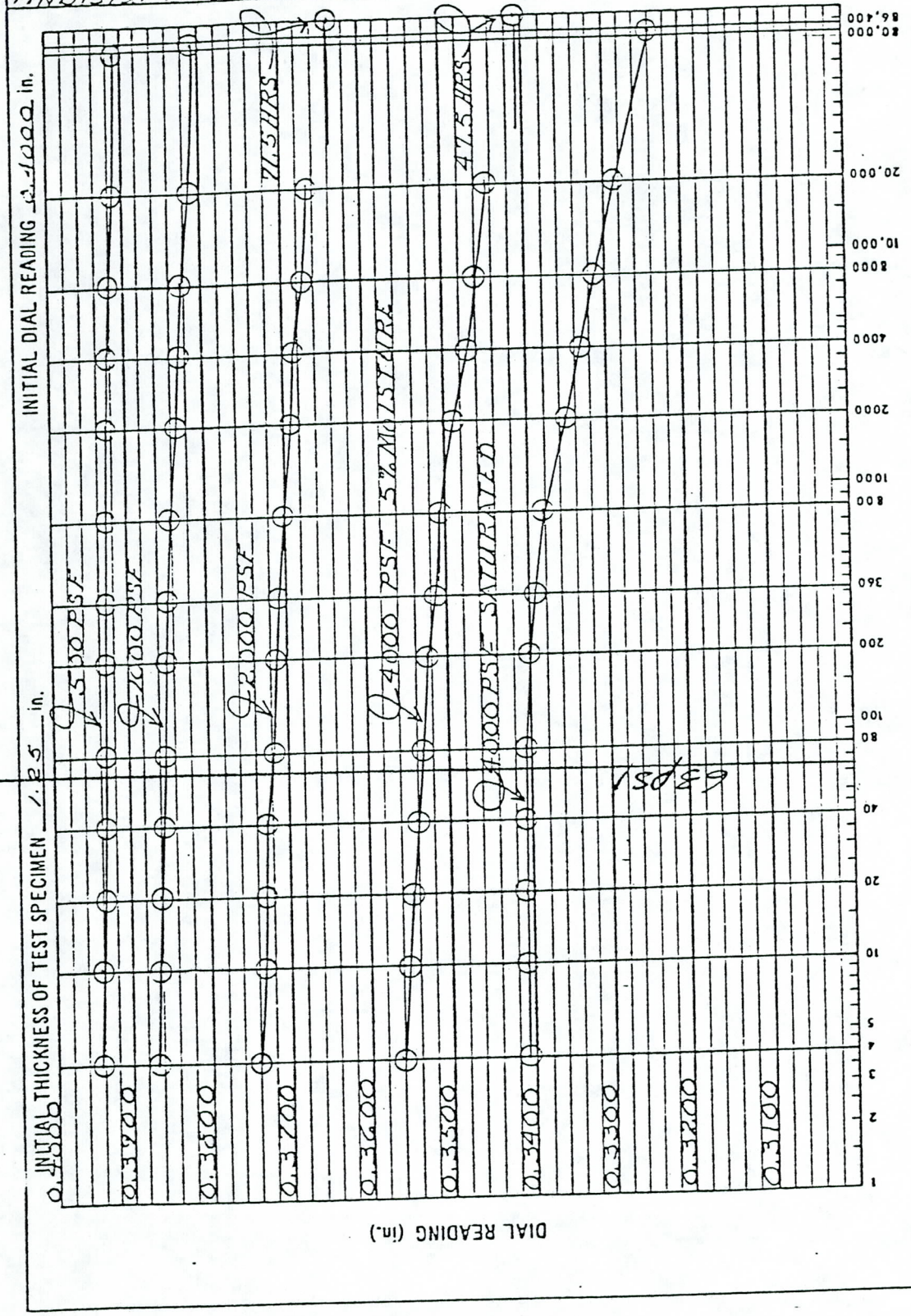
LABORATORY NO. 80W528

| MATERIALS TESTING REPORT | U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE | LOG TIME CONSOLIDATION |
|---|---|---|

PROJECT and STATE: HAYHUALA VALLEY ARIZONA
SAMPLE LOCATION: STA 601+25

| FIELD SAMPLE NO. | DEPTH | GEOLOGIC ORIGIN | |
|---|---|---|---|
| 1601.2 | 12.0'-14.5' | | |
| TYPE OF SAMPLE | TESTED AT | APPROVED BY | DATE |
| UNDISTURBED | SML-LINCOLN | | |



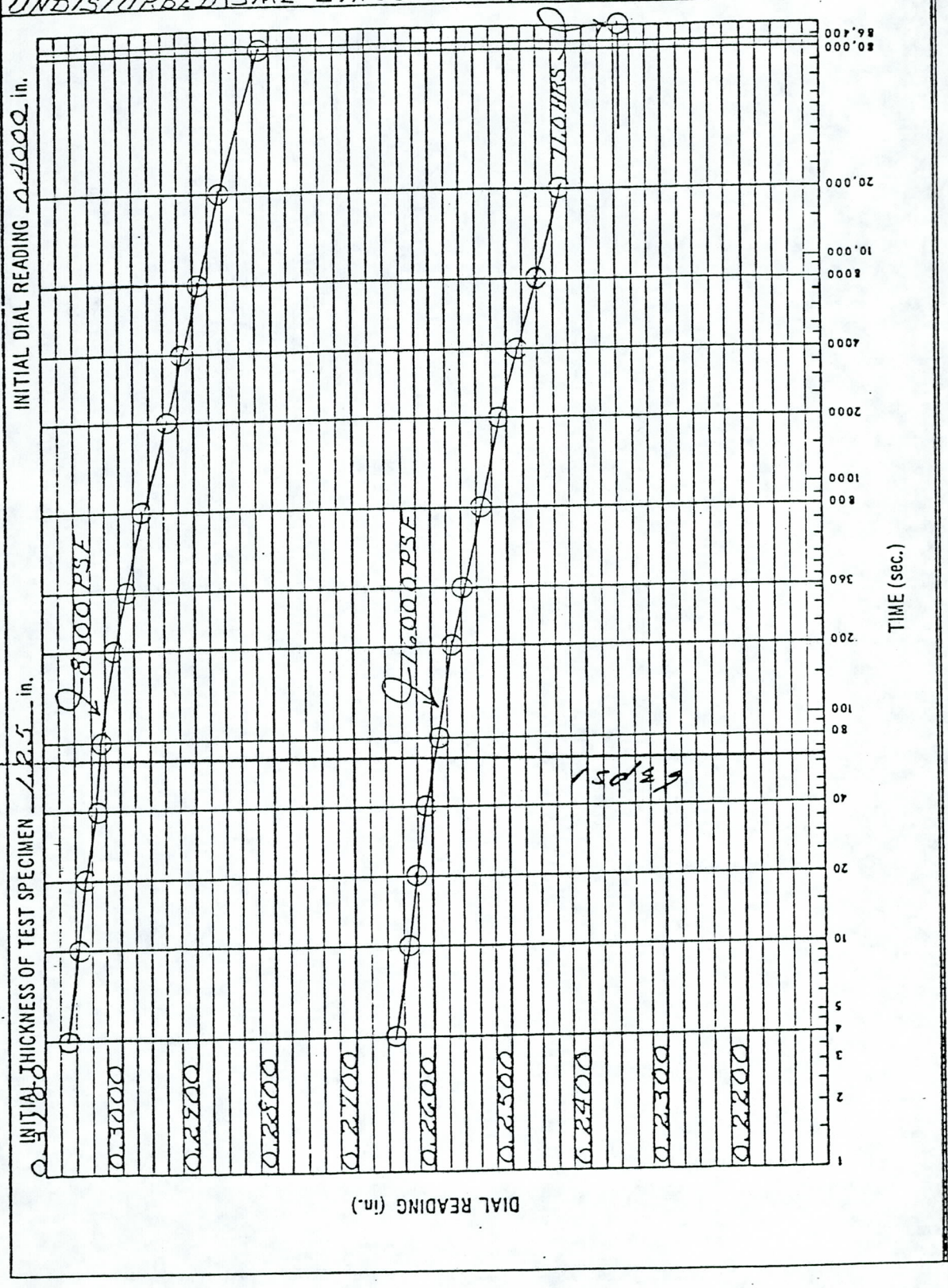

REMARKS

SCS-ENG-126A
Rev. 5-72

17 of 27
LABORATORY NO. 80W52

| MATERIALS TESTING REPORT | U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE | LOG TIME CONSOLIDATION |
|---|---|---|

| PROJECT and STATE | | SAMPLE LOCATION |
|---|---|---|
| HARQUAHALA VALLEY ARIZONA | | STA 601+25 |
| FIELD SAMPLE NO. 1601.2 | DEPTH 12.0'-14.5' | GEOLOGIC ORIGIN |
| TYPE OF SAMPLE UNDISTURBED | TESTED AT SML-LINCOLN | APPROVED BY / DATE |



Az Harquahala FRS
RM 6-5-80
Settlement R-2



| Pressure (ksf) | dial reading (in) @ 63 sec | dial read (in) @ 8 |
|---|---|---|
| 0.5 | 0.3930 | 0.391 |
| 1.0 | 0.3850 | 0.381 |
| 2.0 | 0.3720 | 0.364 |
| 4.0 | 0.3530 | 0.341 |
| 4.0* | 0.3400 | 0.324 |
| 8.0* | 0.3030 | 0.281 |
| 16.0* | 0.2600 | 0.23 |

*saturated

5 Compute accumulated percent consolidation and prepare table

$$\frac{(\text{dial before new load applied}) - (\text{dial @ 63 sec after new load applied})}{(\text{dial @ start of test}) - (\text{dial @ end of test})}$$

Az Harquahala FRS
PJM 6-5-80

19 of 27

| Pressure (KSF) | Computation | Incr. Consol. (%) | Acc. Consol. (%) |
|---|---|---|---|
| 0.5 | $\frac{0.4000-0.3930}{0.4000-0.2350} = \frac{0.007}{0.165} \times 100$ | 4.2 | 4.2 |
| 1.0 | $\frac{0.3910-0.3850}{0.4000-0.2350} = \frac{0.006}{0.165} \times 100$ | 3.6 | 7.8 |
| 2.0 | $\frac{0.3810-0.3720}{0.4000-0.2350} = \frac{0.009}{0.165} \times 100$ | 5.5 | 13.3 |
| 4.0 | $\frac{0.3640-0.3530}{0.4000-0.2350} = \frac{0.011}{0.165} \times 100$ | 6.7 | 20.0 |
| 4.0* | $\frac{0.3410-0.3400}{0.4000-0.2350} = \frac{0.001}{0.165} \times 100$ | 0.6 | 20.6 |
| 8.0* | $\frac{0.3240-0.3030}{0.4000-0.2350} = \frac{0.021}{0.165} \times 100$ | 12.7 | 33.3 |
| 16.0* | $\frac{0.2810-0.2600}{0.4000-0.2350} = \frac{0.021}{0.165} \times 100$ | 12.7 | 46.0 |

6 Plot accumulative percent consolidation vs pressure

for $(p + \Delta p) = 3.87$ KSF

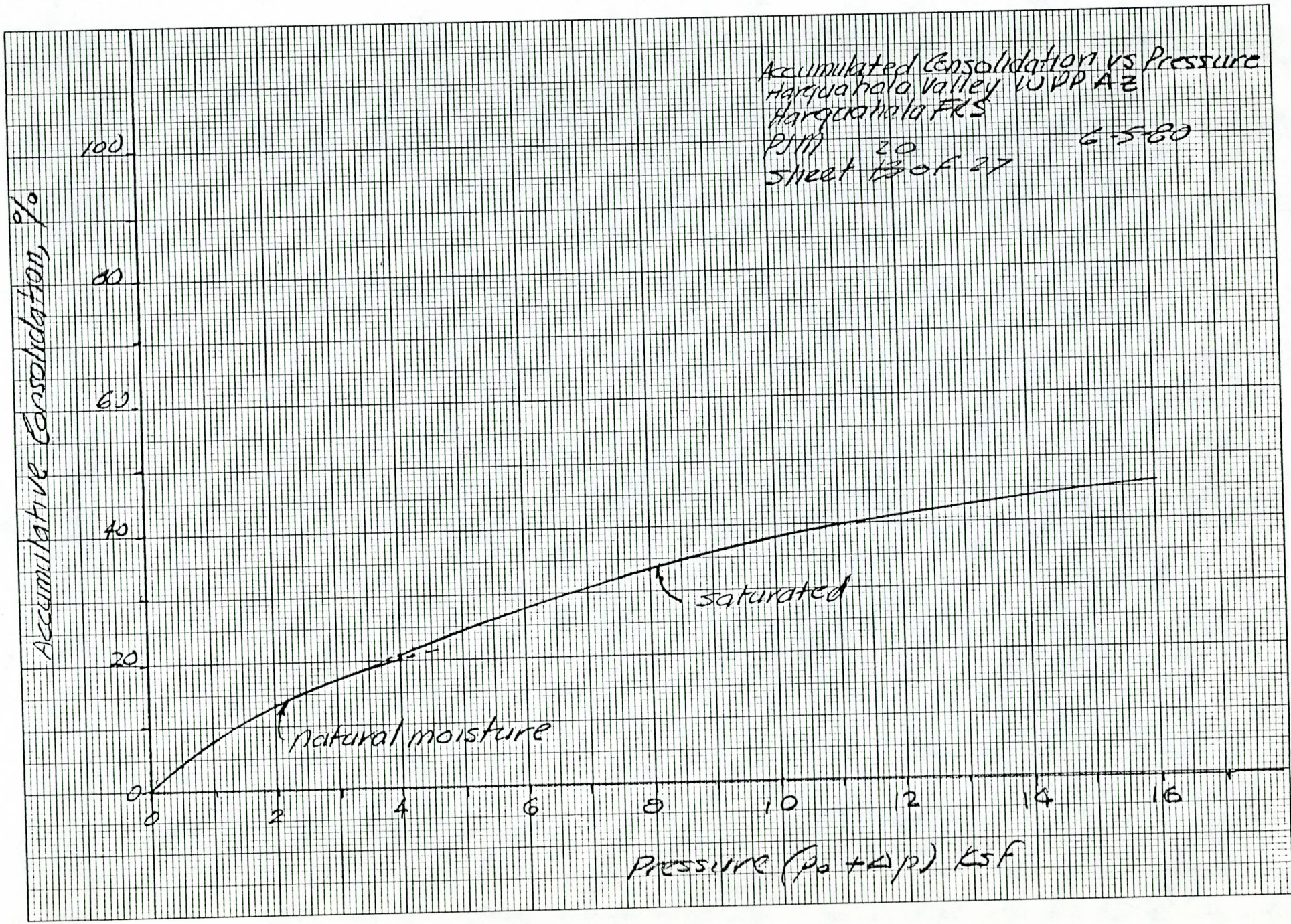
@ natl moisture $S = .198(0.735) = \underline{0.146}'$
resid. settlemt = 0.589'

@ sat moisture $S = .203(0.735) = \underline{0.149}'$
resid. settlemt = 0.586'

K&E 20 X 20 TO THE INCH • 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.



Accumulated Consolidation vs Pressure
Harquahala Valley WMPAZ
Harquahala FRS
PJM 20 6-5-80
Sheet 13 of 27




8701335
2004127

Az Harquahala FRS
PJM 6-5-80
Settlement R-2



Degree of consolidation 35' - 40'
2mo construction period

1. $H_f$: 5
2. $H_e$ = 1.25
3. Case 1, Fig 14-12 applies
   From Table 14-3
   $t_e = 3.38(4)(1.25) = 16.92$ h
   = 10205 s
4. From Log Time Consolidation curve for sample 530B

| Pressure (ksf) | dial reading (in) @1020sec | dial reading (in) @86,40 |
|---|---|---|
| 0.5 | 0.3940 | 0.3930 |
| 1.0 | 0.3910 | 0.3900 |
| 2.0 | 0.3870 | 0.3860 |
| 4.0 | 0.3830 | 0.3820 |
| 4.0* | 0.3720 | 0.3690 |
| 8.0* | 0.3540 | 0.3390 |
| 16.0* | 0.3080 | 0.2850 |

5 Compute accumulated percent consolidation and prepare table

$$\frac{(\text{dial before new load applied}) - (\text{dial @ 1020 sec after new load applied})}{(\text{dial @ start of test}) - (\text{dial @ end of test})}$$

SCS-ENG-128
REV. 4-71

220 of 27 LABORATORY NO 60W5308
89 of 335

| MATERIALS TESTING REPORT | U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE | CONSOLIDATION TEST |
|---|---|---|

PROJECT and STATE: HARQUAHALA VALLEY ARIZONA
SAMPLE LOCATION: STA 601+25

| FIELD SAMPLE NO. | DEPTH | GEOLOGIC ORIGIN | |
|---|---|---|---|
| 1601.4 | 33.0'-35.5' | | |
| TYPE OF SAMPLE | TESTED AT | APPROVED BY | DATE |
| UNDISTURBED | SML-LINCOLN | | |

CLASSIFICATION SM

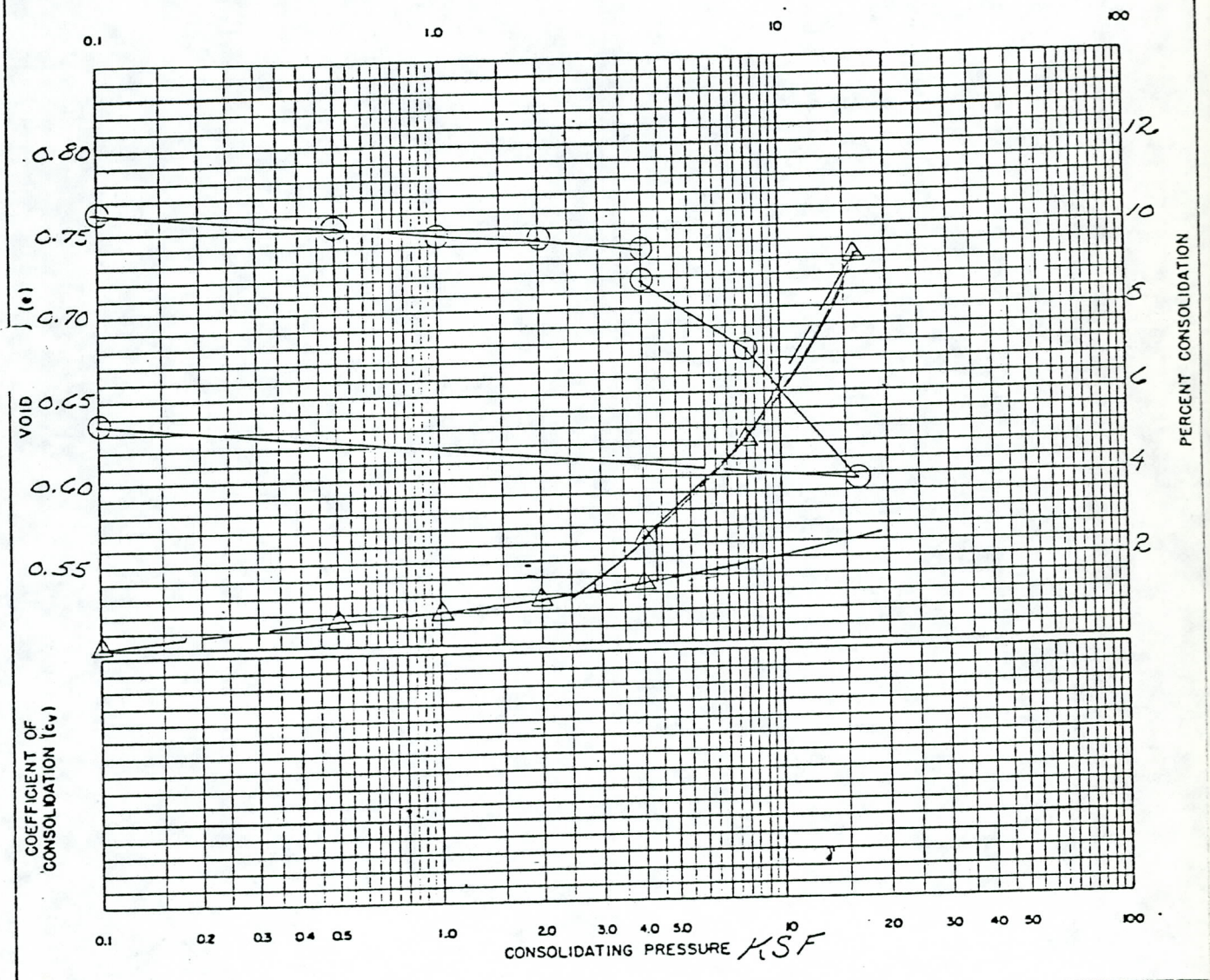
$G_s$ 2.69 LL 35 PI 10

INITIAL DENSITY $\gamma_d$ 1.53 g/cc

INITIAL VOID RATIO, $e_o$ 0.7616

COMPRESSION INDEX, $C_c$

TEST SPECIFICATIONS:
Saturated at 4000 PSF




REMARKS

Water Content of Specimen When Trimmed = 9.7%

Water Content of Specimen at Start of test = 5.0%

SCS-ENG-128A
Rev. 5-72

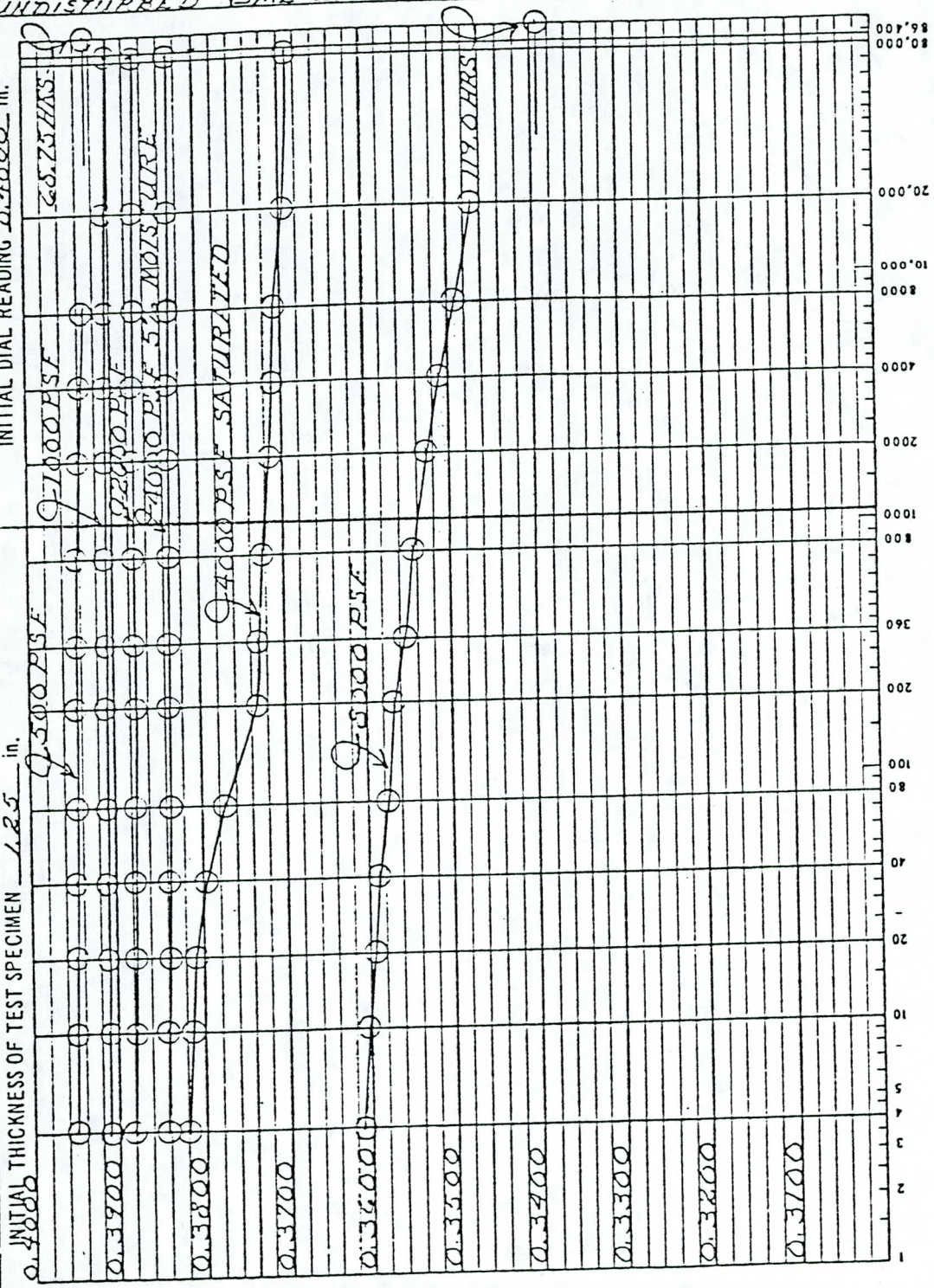
23 of 27 LABORATORY NO. 80W530

| MATERIALS TESTING REPORT | U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE | LOG TIME CONSOLIDATION |
|---|---|---|

| PROJECT and STATE | | SAMPLE LOCATION |
|---|---|---|
| HEFQUAHALE VALLEY ARIZONA | | STA 601+25 |
| FIELD SAMPLE NO. 1601.4 | DEPTH 33.0'-35.5' | GEOLOGIC ORIGIN |
| TYPE OF SAMPLE UNDISTURBED | TESTED AT SML-LINCOLN | APPROVED BY / DATE |

INITIAL DIAL READING 0.1000 in.

INITIAL THICKNESS OF TEST SPECIMEN 1.25 in.




REMARKS

SCS-ENG-128A
Rev. 5-72

24 of 27 910 of 335
LABORATORY NO. 80W530

| MATERIALS TESTING REPORT | U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE | LOG TIME CONSOLIDATION |
|---|---|---|

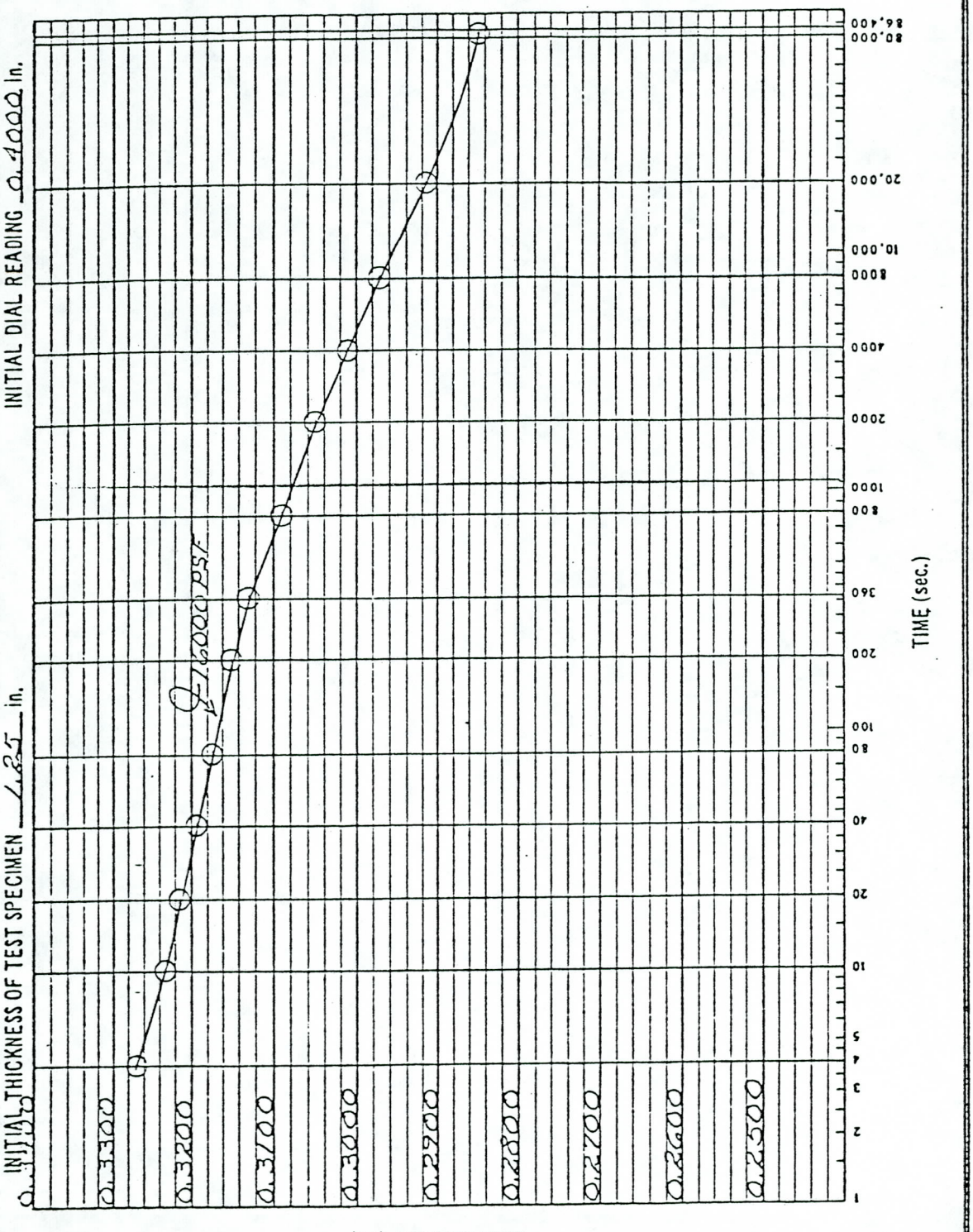
| PROJECT and STATE | SAMPLE LOCATION |
|---|---|
| HARQUAHALA VALLEY ARIZONA | STA 601+25 |

| FIELD SAMPLE NO. | DEPTH | GEOLOGIC ORIGIN |
|---|---|---|
| 1601.4 | 33.0'-35.5' | |

| TYPE OF SAMPLE | TESTED AT | APPROVED BY | DATE |
|---|---|---|---|
| UNDISTURBED | SML-LINCOLN | | |

INITIAL DIAL READING 0.4000 in.

INITIAL THICKNESS OF TEST SPECIMEN 1.25 in.




REMARKS

Az Harquahala FRS
RJM 6-5-80
Settlement L-2



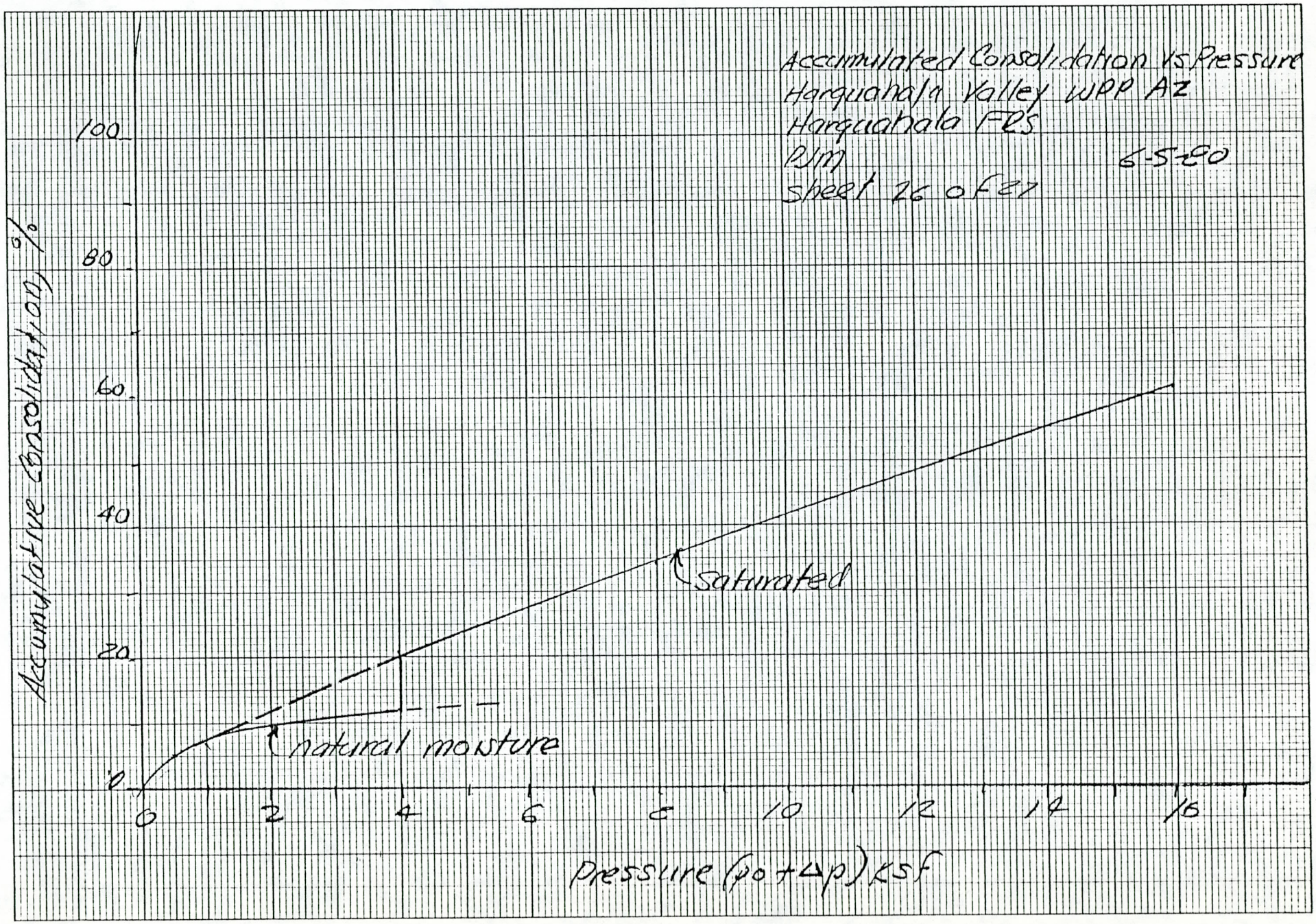
| Pressure (tsf) | Computation | Incr. Consol. (%) | Acc. Consol. (%) |
|---|---|---|---|
| 0.5 | $\frac{0.4000-0.3940}{0.4000-0.2850}=\frac{0.006}{0.115}\times 100$ | 5.2 | 5.2 |
| 1.0 | $\frac{0.3930-0.3910}{0.4000-0.2850}=\frac{0.002}{0.115}\times 100$ | 1.7 | 6.9 |
| 2.0 | $\frac{0.3900-0.3870}{0.4000-0.2850}=\frac{0.003}{0.115}\times 100$ | 2.6 | 9.5 |
| 4.0 | $\frac{0.3860-0.3830}{0.4000-0.2850}=\frac{0.003}{0.115}\times 100$ | 2.6 | 12.1 |
| 4.0* | $\frac{0.3820-0.3720}{0.4000-0.2850}=\frac{0.010}{0.115}\times 100$ | 8.7 | 20.8 |
| 8.0* | $\frac{0.3690-0.3540}{0.4000-0.2850}=\frac{0.015}{0.115}\times 100$ | 13.4 | Neg 1.Pl. 34.2 |
| 16.0* | $\frac{0.3390-0.3080}{0.4000-0.2850}=\frac{0.031}{0.115}\times 100$ | 27.0 | 61.2 |

6. Plot accumulative percent consolidation vs. pressure
For $(p_o+\Delta p)=4.19$ ksf
@ natl moisture $S=.12(0.078)=0.009'$
resid. settlement = $\underline{0.069'}$

@ Sat moisture $S=.21(0.078)=0.016$
resid. settlement = $\underline{0.062'}$

K•Σ 20 X 20 TO THE INCH • 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.





AZ Harquahala FRS

RM 6-5-80

settlement R-2



Summary of residual Settlement after 2 mo construction period.

1. @ natural moisture

| | | |
|---|---|---|
| ~~0-8'~~ | ~~0.186~~ | |
| 0 ~~8~~-12' | ~~0.186~~ | 0.743 |
| 12-16' | 0.156 | |
| 16-35' | 0.589 | |
| 35-40' | 0.069 | |
| | ~~1.488~~' Total | 1.557' |

2. @ Saturated to 12'; natural moisture below

| | | |
|---|---|---|
| ~~0-8'~~ | ~~0.161~~ | |
| 0 ~~8~~-12' | ~~0.138~~ | 0.570 |
| 12-16' | 0.156 | |
| 16-35' | 0.589 | |
| 35-40' | 0.069 | |
| | ~~1.413~~' Total | 1.384' |

AE Harquahala FRS
PJM 2/22/80
Embankment Design 1 4

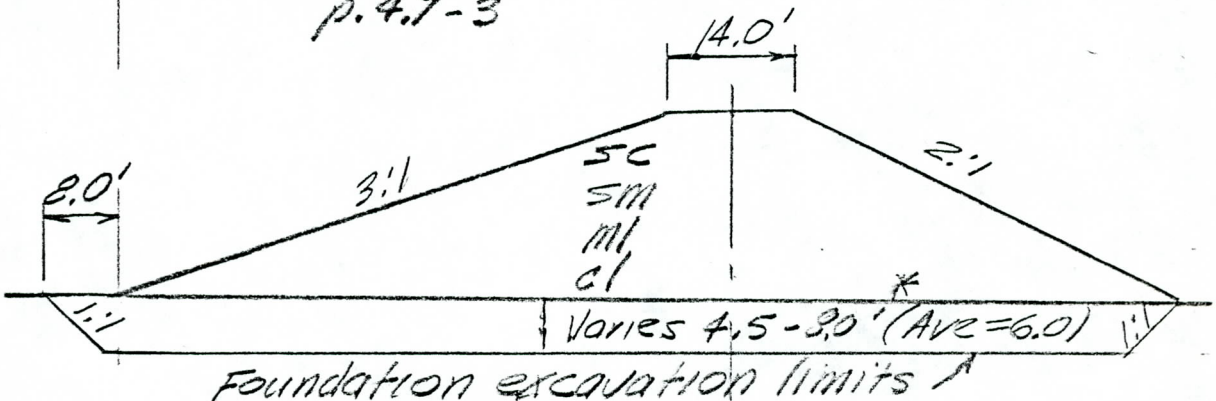
Design an Embankment Section for Reach 2 (Station 433+65± to Station 717+00±) by processing and examining a minimum of three alternatives and selecting one for comparison with Reach 1 selection.

---

Alternative 1

Work Plan Section

Ref: Supplement No. 1
Harquahala Valley Watershed
Engineering Documentation
Volume I May 1976
p. 4.7-3

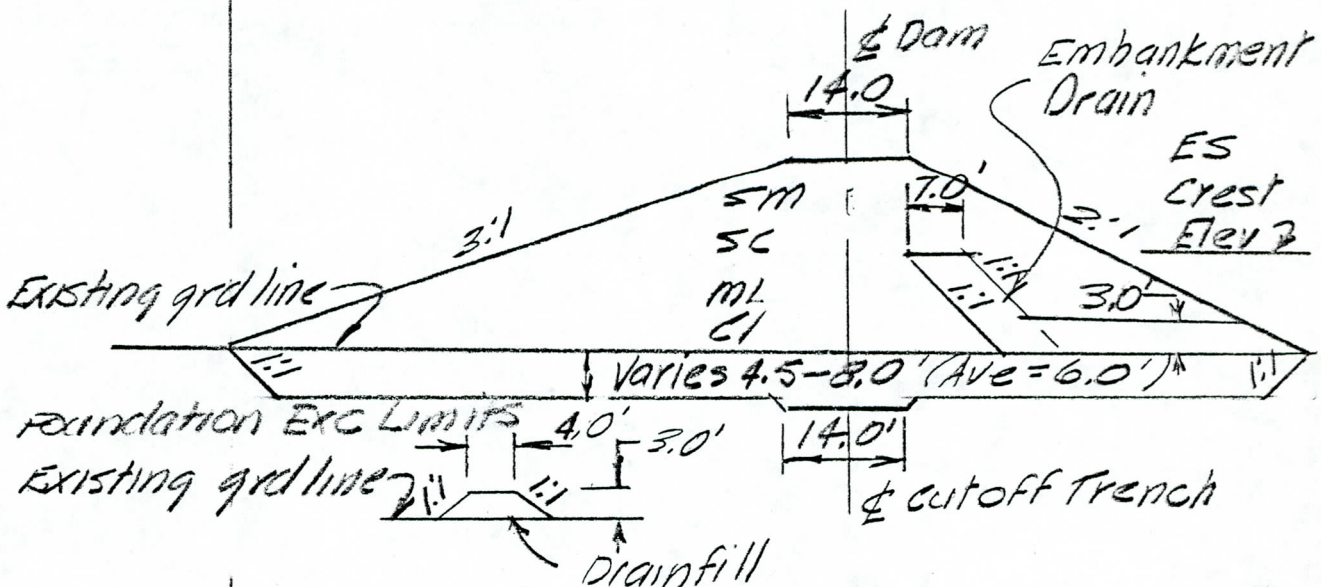



* Ref: Preliminary Geologic Investigation
p30 & 33

AZ Harquahala FRS
PJM 2/22/80
Embankment Design 2 4

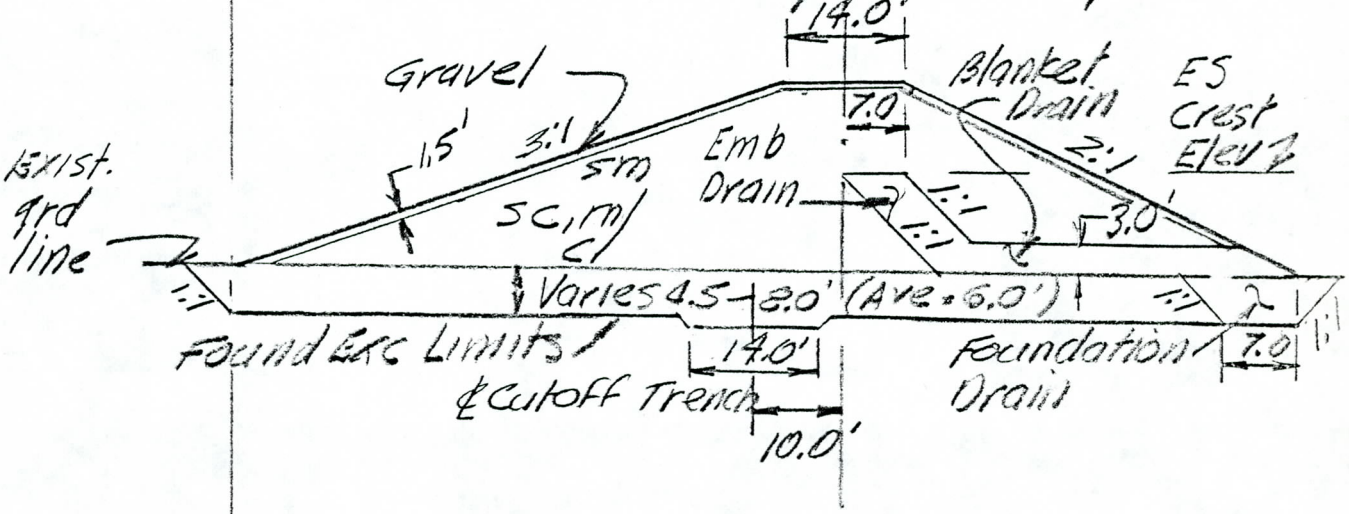
## Alternative 2

### Preliminary Design Section




## Alternative 3

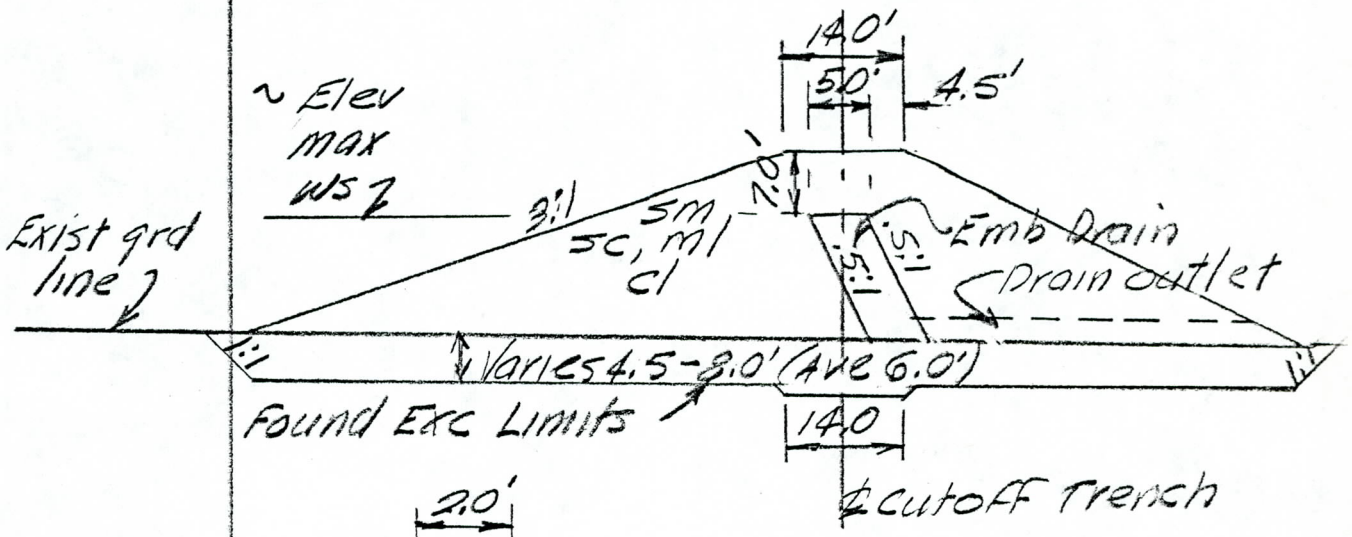
### Based on Recommended Design Review Rept Section

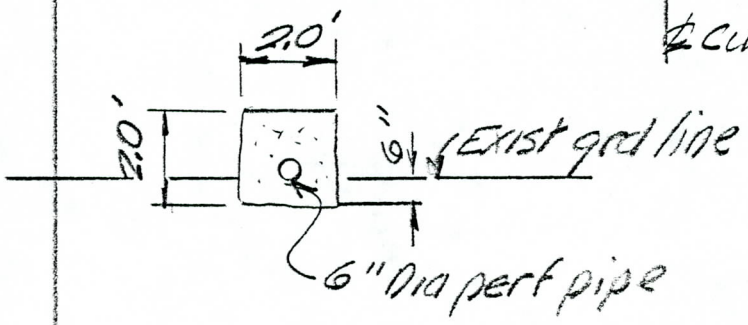


AZ Harquahala FRS
RJM 2/22/80
Embankment Design 3 4

## Alternative 4

Based on saddleback FRS section



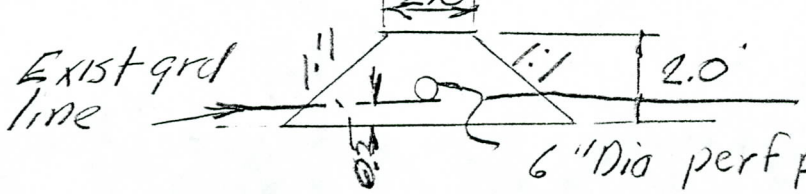




Cross Section
Drain Outlet

Foundation drain will be checked later.

---

Revise Drain Outlet Alt 4




Place @ 400' c.c.

STABILITY - REACH 1 & 2

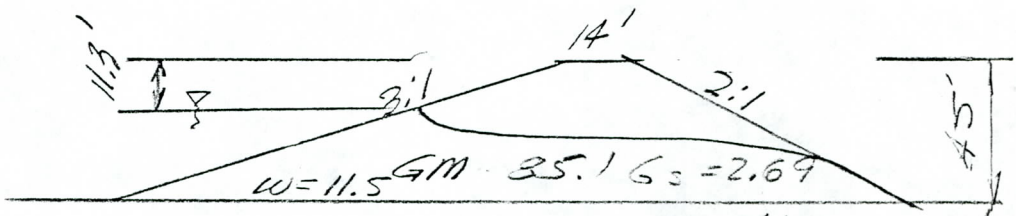
AZ Harquahala FRS
RJM 2/25/80
Embankment Design 4 4

Use Alternate 4 subject to check when Reach 1 is selected.

AZ Harquahala FRS
RIM 6-12-80
Reach 1 1 3

1419.7
1408.4
11.3

sta 1045+70 -




GM silty gravel w cobbles

Phreatic Line

TP11
$G_s$ = 2.62

H = 45
h = 33.7
m = 101.1
.3m = 30.3
d = 137.9

materials

| | Embankment | Foundation |
|---|---|---|
| $\gamma_d$ | 112.6 | 112.8 |
| $\gamma_m$ | 125.6 | |
| $\gamma_{sat}$ | 133.1 | 132.1 |
| $\phi$ | 23° | 23° |
| C | 750 psf | 750 psf |
| $\phi_r$ | 39° | 39° |
| $C_r$ | 100 psf | 100 psf |

Embankment

$\gamma_m = \gamma_d(1+w)$
$= 112.6(1.115)$
$= 125.6$ pcf

$\gamma_{sat} = \gamma_d(1+w_{sat})$
$= 112.6(1.182)$
$= 133.1$ pcf

$w_{sat} = \frac{\gamma_w}{\gamma_d} - \frac{1}{G_s}$
$= \frac{62.4}{112.6} - \frac{1}{2.69} = .182$

AZ Harquahala FRS
RM 6-12-80

2 3

Foundation

$$w_{sat} = \frac{\gamma_w}{\gamma_d} - \frac{1}{G_s}$$

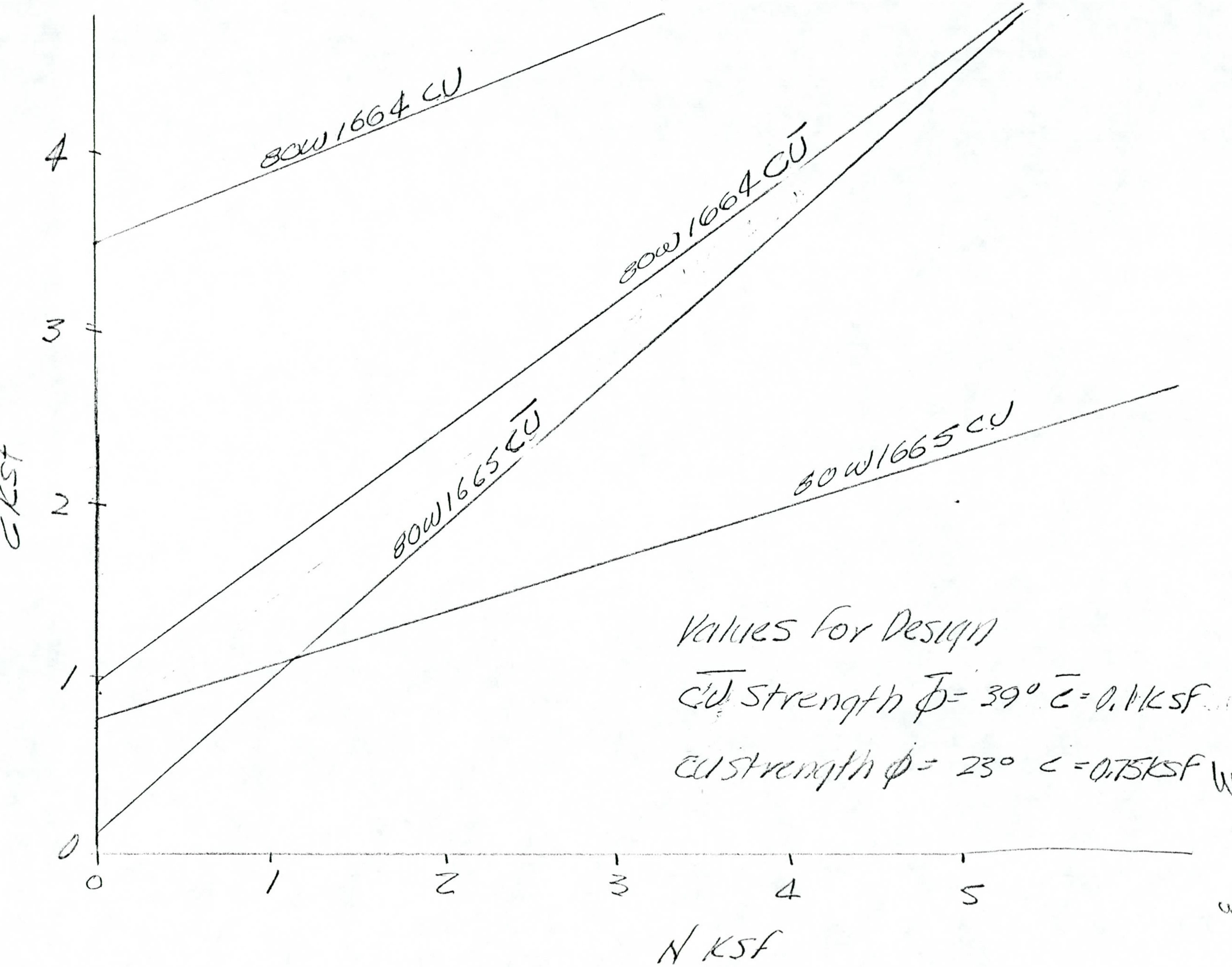
$$= \frac{62.4}{112.8} - \frac{1}{2.62}$$

$$= .172$$

$$\gamma_{sat} = \gamma_{dl}(1 + w_{sat})$$

$$= 112.8(1.172)$$

$$= 132.1 \text{ pcf}$$




Az Rm 6-12-80 Harquahala FTc5

200

300

400

500

1520

1490

1460

1430

1400

1370

1340

(495, 1480)

(455, 1450)

(393, 1420) (471, 1420)

3:1

3:1

(100, 1374) (203, 1374) (496, 1374) (600, 1374)

STA 104+70

HARQUAHALA VALLEY WPPA
HARQUAHALA FRS
END CONSTRUCTION COND.
STA 104+70

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed — Date — Approved by —
Drawn — Title —
Traced — Title —
Checked — Sheet No. of — Drawing No.

SCS-ENG-315A REV 8-75

```
*TERMINAL INACTIVE*
>


   ) S04PM,160400010ICT,SCS-AZ
D..E: 061680  TIME: 160200

>@ASG,A PRINT4.
READY
>@ED,U PRINT4.
CASE UPPER ASSUMED
ED 15R2-MON-06/16/80-16:02:40-(0,1)
EDIT
0:>P 1 80
@QUAL  SEB
@ASG,A  *LEASESYS.
@USE  PF,*LEASESYS
@ASG,A  *LEASECDL.
@USE  SUB2,*LEASECDL
@ASG,A  *LEASEMODS.
@USE  SUB1,*LEASEMODS
@USE  E,*LEASEMODS
@ASG,A  *LEASESYSDIC.
@USE  DD3,*LEASESYSDIC
@PF.ICES,Z
*********************************************
*                                           *
*          UNIVAC 1100 SERIES ICES          *
*     JUN 16, 1980              14:14:12     *
*                VERSION 1.1                *
*                                           *
*********************************************
FILES USED BY THIS RUN
DD1:  NOT ASSIGNED, TEMPORARY USED
DD2:  NOT ASSIGNED, TEMPORARY USED
DD3:  SEB              *   LEASESYSDIC
DD4:  NOT ASSIGNED, TEMPORARY USED
LEASE $ HARQUAHALA FRS
$ ZU=3:1
$ ZD=2:1
$ ELEV TOP OF DAM IS 1419.7  MAX HT. IS 45 FEET
$ END OF CONSTRUCTION CONDITION
$ EMBANKMENT (39-100) FOUNDATION (39-100)
POINT  1  100 1374
2  263 1374
3  393 1420
4  407 1420
5  496 1374
6  600 1374
LINE  1  1  2  2
2  2  3  1
3  3  4  1
4  4  5  1
5  5  6  2
6  2  5  2
SOIL  1  125.6  100  39
   32.1  100  39
   Z  2  1  100  1374
2  2  263  1374
2  5  496  1374
2  6  600  1374
NUMBER OF SLICES 30
SET YMIN 1360
RMIN TANGENT LINE 2 3 4
```

PIEZOMETRIC SURFACE DATA

PIEZ SURFACE NO. 2

| NO. | XCOORD | YCOORD |
|---|---|---|
| 1 | 100.00 | 1374.00 |
| 2 | 263.00 | 1374.00 |
| 5 | 496.00 | 1374.00 |
| 6 | 600.00 | 1374.00 |

ORDERED LINE ARRAY / BNDS ARRAY

| NO | PT | PT | SOIL | X-LEFT | Y-LEFT | X-RIGHT | Y-RIGHT | SL |
|---|---|---|---|---|---|---|---|---|
| PE 1 | 1 | 2 | 2 | 100.00 | 1374.00 | 263.00 | 1374.00 | . |
| 000 2 | 2 | 3 | 1 | 263.00 | 1374.00 | 393.00 | 1420.00 | . |
| 354 3 | 3 | 4 | 1 | 393.00 | 1420.00 | 407.00 | 1420.00 | . |
| 000 4 | 4 | 5 | 1 | 407.00 | 1420.00 | 496.00 | 1374.00 | -. |
| 517 5 | 5 | 6 | 2 | 496.00 | 1374.00 | 600.00 | 1374.00 | . |
| 000 6 | 2 | 5 | 2 | 263.00 | 1374.00 | 496.00 | 1374.00 | . |

NUMBER OF TOPLINES IS 5

FSBSHP FSNRML RADIUS NO.SLCS. X= 455.00 Y= 1450.00

| | | | |
|---|---|---|---|
| 3.270 | 2.832 | 90.00 | 7 |
| 3.161 | 2.751 | 87.52 | 7 |
| 3.051 | 2.668 | 85.04 | 7 |
| 2.946 | 2.587 | 82.56 | 7 |
| 2.843 | 2.508 | 80.09 | 7 |

80:>P

P 81 160

| | | | |
|---|---|---|---|
| 2.745 | 2.431 | 77.61 | 7 |
| 2.672 | 2.351 | 75.13 | 5 |
| 2.587 | 2.292 | 72.65 | 5 |
| 2.503 | 2.234 | 70.17 | 5 |
| 2.420 | 2.180 | 67.69 | 5 |
| 2.340 | 2.128 | 65.21 | 5 |
| 2.266 | 2.083 | 62.74 | 5 |

TOO FEW SLICES AT RAD= 60.26

THE LOWEST FACTOR OF SAFETY FOUND WAS 2.266 AT R= 62.74

FSBSHP FSNRML RADIUS NO.SLCS. X= 468.83 Y= 1460.00

| | | | |
|---|---|---|---|
| 2.929 | 2.573 | 100.00 | 8 |
| 2.801 | 2.476 | 97.82 | 8 |
| 2.682 | 2.385 | 95.64 | 8 |
| 2.577 | 2.304 | 93.47 | 8 |
| 2.477 | 2.211 | 91.29 | 6 |
| 2.405 | 2.161 | 89.11 | 6 |
| 2.343 | 2.117 | 86.93 | 6 |

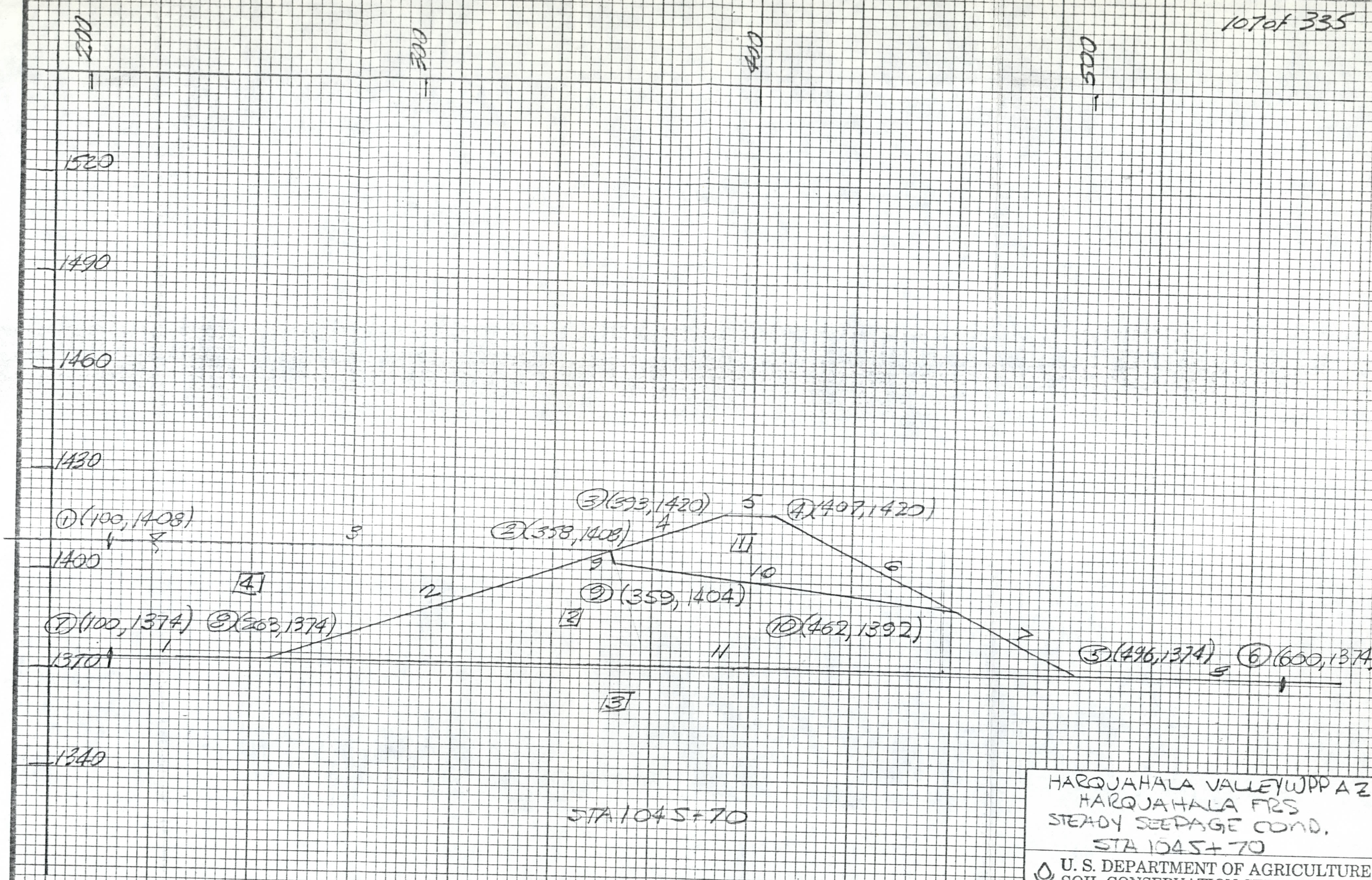
```
 2.233   2.045    82.57     6
 2.221   2.040    80.40     5
 2.129   1.960    78.22     4
 2.106   1.959    76.04     4
 2.100   1.978    73.86     4
 2.124   2.029    71.68     4
 2.103   1.961    75.49     4
 2.100   1.965    74.95     4
 2.099   1.970    74.41     4
 2.103   1.987    73.32     4
 2.108   1.999    72.77     4
 2.114   2.013    72.23     4
TOO FEW SLICES AT RAD=    69.50
THE LOWEST FACTOR OF SAFETY FOUND WAS 2.099 AT R=    74.41

FSBSHP FSNRML RADIUS NO.SLCS. X=  481.67  Y= 1470.00
 2.815   2.485   110.00     9
 2.679   2.370   108.12     8
 2.569   2.289   106.24     8
 2.462   2.211   104.37     8
 2.364   2.138   102.49     7
 2.268   2.068   100.61     7
 2.184   2.008    98.73     7
 2.123   1.964    96.85     6
 2.061   1.909    94.98     5
 2.045   1.909    93.10     5
 2.038   1.918    91.22     5
 2.084   1.973    89.34     4
 2.042   1.910    92.63     5
 2.040   1.912    92.16     5
 2.038   1.914    91.69     5
 2.038   1.922    90.75     5
 2.084   1.963    90.28     4
 2.083   1.968    89.81     4
 2.094   2.006    87.46     4
TOO FEW SLICES AT RAD=    85.59
THE LOWEST FACTOR OF SAFETY FOUND WAS 2.038 AT R=    91.22

FSBSHP FSNRML RADIUS NO.SLCS. X=  495.00  Y= 1480.00
 2.883   2.544   120.00     9
 2.778   2.467   118.42     9
 2.674   2.390   116.84     9
 2.570   2.313   115.27     9
 2.471   2.238   113.69     8
 2.339   2.128   112.11     7
 2.248   2.066   110.53     7
 2.161   2.007   108.96     6
 2.080   1.954   107.38     6
 2.014   1.914   105.80     5
 2.019   1.933   104.22     5
 2.062   1.943   106.98     6
 2.046   1.933   106.59     6
 2.030   1.920   106.20     5
 2.015   1.918   105.41     5
 2.016   1.923   105.01     5
 2.017   1.928   104.62     5
 2.035   1.963   102.65     5
 2.057   1.993   101.07     4
TOO FEW SLICES AT RAD=    99.49
THE LOWEST FACTOR OF SAFETY FOUND WAS 2.014 AT R=   105.80

160:>
```

```
 THE MINIMUM FACTOR OF SAFETY IS  2.014 FOR X=  495.00  Y= 1480.00  R=  105.80
**** INPUT ERROR 7.16 - ATTEMPT TO READ BEYOND END OF FILE ON INPUT.
@BRKPT PRINT$
EOF:163 SCAN:2
0:>
```




HARQUAHALA VALLEY WPP AZ
HARQUAHALA FRS
STEADY SEEPAGE COND.
STA 1045+70

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed ____ Date
Drawn ____
Traced ____
Checked ____
Approved by ____
Title ____
Title ____
Sheet No. ____ of ____
Drawing No. ____

```
@ASG,A PRINT5.
READY
>@ED,U PRINT5.
CASE UPPER ASSUMED
[ 15R2-MON-06/16/80-16:10:12-(0,1)
*
b.>P 1 80
@QUAL  SEB
@ASG,A  *LEASESYS.
@USE  PF,*LEASESYS
@ASG,A  *LEASECDL.
@USE  SUB2,*LEASECDL
@ASG,A  *LEASEMODS.
@USE  SUB1,*LEASEMODS
@USE  E,*LEASEMODS
@ASG,A  *LEASESYSDIC.
@USE  DD3,*LEASESYSDIC
@PF.EGW?,Z
**************************************************
*                                                *
*      ↑      UNIVAC 1100 SERIES ICES            *
*      JUN 16, 1980                14:14:48      *
*                VERSION 1.1                     *
*                                                *
**************************************************
FILES USED BY THIS RUN
DD1:  NOT ASSIGNED, TEMPORARY USED
DD2:  NOT ASSIGNED, TEMPORARY USED
DD3:  SEB              *   LEASESYSDIC
DD4:  NOT ASSIGNED, TEMPORARY USED
LEASE $ HARQUAHALA FRS
  D=3:1  ZD=2:1  TOP OF DAM ELEV IS 1419.7
$ MAX HT. IS 45 FEET  ES CREST ELEV IS 1408.4
$ STEADY SEEPAGE CONDITION
$ EMBANKMENT (39-100)( FOUNDATION (39-100)
POINT 1 100 1408
2 358 1408
3 393 1420
4 407 1420
5 496 1374
6 600 1374
7 100 1374
8 263 1374
9 359 1404
10 462 1392
LINE 1 7 8 3
2 8 2 2
3 1 2 4
4 2 3 1
5 3 4 1
6 4 10 1
7 10 5 2
8 5 6 3
9 2 9 2
10 9 10 2
11 8 5 3
  1 125.6 100 39
  3.1 100 39
  2.1 100 39
4 62.4 0 0
PIEZ 2 1 100 1408
2 2 358 1408
2 9 359 1404
2 10 462 1392
```

NUMBER OF SLICES 30
SET YMIN 1360
RMIN TANGENT LINE 4 5 6 7 8
GRID 1 455 1450 2 455 1450 3 495 1480 0 3

PIEZOMETRIC SURFACE DATA

PIEZ SURFACE NO. 2

| NO. | XCOORD | YCOORD |
|---|---|---|
| 1 | 100.00 | 1408.00 |
| 2 | 358.00 | 1408.00 |
| 9 | 359.00 | 1404.00 |
| 10 | 462.00 | 1392.00 |
| 5 | 496.00 | 1374.00 |
| 6 | 600.00 | 1374.00 |

| ORDERED LINE ARRAY | | | | BNDS ARRAY | | | | |
|---|---|---|---|---|---|---|---|---|
| NO | PT | PT | SOIL | X-LEFT | Y-LEFT | X-RIGHT | Y-RIGHT | SLO |
| PE | | | | | | | | |
| 3 | 1 | 2 | 4 | 100.00 | 1408.00 | 358.00 | 1408.00 | . |
| 000 | | | | | | | | |
| 4 | 2 | 3 | 1 | 358.00 | 1408.00 | 393.00 | 1420.00 | . |
| 343 | | | | | | | | |
| 80:> | | | | | | | | |
| 1 160 | | | | | | | | |
| 5 | 3 | 4 | 1 | 393.00 | 1420.00 | 407.00 | 1420.00 | |
| . | | | | | | | | |
| 000 | | | | | | | | |
| 6 | 4 | 10 | 1 | 407.00 | 1420.00 | 462.00 | 1392.00 | -. |
| 509 | | | | | | | | |
| 7 | 10 | 5 | 2 | 462.00 | 1392.00 | 496.00 | 1374.00 | -. |
| 529 | | | | | | | | |
| 8 | 5 | 6 | 3 | 496.00 | 1374.00 | 600.00 | 1374.00 | . |
| 000 | | | | | | | | |
| 1 | 7 | 8 | 3 | 100.00 | 1374.00 | 263.00 | 1374.00 | . |
| 000 | | | | | | | | |
| 2 | 8 | 2 | 2 | 263.00 | 1374.00 | 358.00 | 1408.00 | . |
| 358 | | | | | | | | |
| 9 | 2 | 9 | 2 | 358.00 | 1408.00 | 359.00 | 1404.00 | -4. |
| 000 | | | | | | | | |
| 10 | 9 | 10 | 2 | 359.00 | 1404.00 | 462.00 | 1392.00 | -. |
| 117 | | | | | | | | |
| 11 | 8 | 5 | 3 | 263.00 | 1374.00 | 496.00 | 1374.00 | . |

NUMBER OF TOPLINES IS 6

FSBSHP FSNRML RADIUS NO.SLCS. X= 455.00 Y= 1450.00
2.965 2.935 .00 .00 3

| | | | |
|---|---|---|---|
| 3.177 | 2.772 | 87.51 | 7 |
| 3.082 | 2.700 | 85.02 | 7 |
| 2.990 | 2.629 | 82.53 | 7 |
| 2.899 | 2.560 | 80.04 | 7 |
| 2.808 | 2.462 | 77.55 | 5 |
| .724 | 2.402 | 75.06 | 5 |
| .640 | 2.344 | 72.57 | 5 |
| .559 | 2.288 | 70.09 | 5 |
| 2.481 | 2.237 | 67.60 | 5 |
| 2.406 | 2.189 | 65.11 | 5 |

TOO FEW SLICES AT RAD= 62.62
THE LOWEST FACTOR OF SAFETY FOUND WAS 2.406 AT R= 65.11

FSBSHP FSNRML RADIUS NO.SLCS. X= 468.33 Y= 1460.00

| | | | |
|---|---|---|---|
| 2.924 | 2.574 | 100.00 | 8 |
| 2.801 | 2.482 | 97.81 | 8 |
| 2.690 | 2.398 | 95.62 | 8 |
| 2.569 | 2.290 | 93.43 | 7 |
| 2.497 | 2.236 | 91.23 | 6 |
| 2.437 | 2.195 | 89.04 | 6 |
| 2.383 | 2.158 | 86.85 | 6 |
| 2.331 | 2.123 | 84.66 | 6 |
| 2.310 | 2.111 | 82.47 | 5 |
| 2.251 | 2.073 | 80.28 | 5 |
| 2.164 | 1.996 | 78.08 | 4 |
| 2.145 | 1.999 | 75.89 | 4 |
| 2.145 | 2.023 | 73.70 | 4 |
| 2.158 | 1.996 | 77.54 | 4 |
| 2.153 | 1.996 | 76.99 | 4 |
| 2.148 | 1.997 | 76.44 | 4 |
| 2.143 | 2.002 | 75.34 | 4 |
| .142 | 2.007 | 74.80 | 4 |
| .143 | 2.014 | 74.25 | 4 |

O FEW SLICES AT RAD= 71.51
HE LOWEST FACTOR OF SAFETY FOUND WAS 2.142 AT R= 74.80

FSBSHP FSNRML RADIUS NO.SLCS. X= 481.67 Y= 1470.00

| | | | |
|---|---|---|---|
| 2.779 | 2.448 | 110.00 | 8 |
| 2.669 | 2.368 | 108.11 | 8 |
| 2.562 | 2.290 | 106.21 | 8 |
| 2.460 | 2.215 | 104.32 | 8 |
| 2.366 | 2.146 | 102.42 | 7 |
| 2.276 | 2.082 | 100.53 | 7 |
| 2.179 | 2.008 | 98.64 | 6 |
| 2.144 | 1.990 | 96.74 | 6 |
| 2.086 | 1.987 | 94.85 | 5 |
| 2.073 | 1.939 | 92.95 | 5 |
| 2.098 | 1.973 | 91.06 | 4 |
| 2.082 | 1.937 | 94.37 | 5 |
| 2.079 | 1.937 | 93.90 | 5 |
| 2.075 | 1.938 | 93.43 | 5 |
| 2.071 | 1.941 | 92.48 | 5 |
| 2.069 | 1.943 | 92.01 | 5 |
| 2.100 | 1.970 | 91.53 | 4 |
| 2.097 | 1.992 | 89.17 | 4 |
| 2.109 | 2.025 | 87.27 | 4 |
| 2.097 | 1.976 | 90.59 | 4 |
| .097 | 1.981 | 90.11 | 4 |
| .097 | 1.986 | 89.64 | 4 |
| .098 | 1.998 | 88.69 | 4 |
| 2.101 | 2.006 | 88.22 | 4 |
| 2.104 | 2.015 | 87.75 | 4 |

TOO FEW SLICES AT RAD= 85.30
THE LOWEST FACTOR OF SAFETY FOUND WAS 2.069 AT R= 92.01

160:>\N

```
'P 161 240
 JP 1 IS AN ILLEGAL COMMAND.
 1<0:>P 161 240
    BSHP FSNRML RADIUS NO.SLCS. X=  495.00  Y= 1480.00
   2.852  2.23'  120.00     9
   2.751  2.449  118.40     9
   2.650  2.375  116.81     9
   2.550  2.302  115.21     9
   2.453  2.230  113.61     8
   2.327  2.124  112.02     7
   2.239  2.064  110.42     7
   2.155  2.008  108.83     6
   2.078  1.959  107.23     6
   2.022  1.927  105.63     5
   2.027  1.946  104.04     5
   2.062  1.949  106.83     6
   2.046  1.940  106.43     6
   2.028  1.928  106.03     5
   2.023  1.931  105.23     5
   2.023  1.935  104.83     5
   2.025  1.940  104.44     5
   2.043  1.976  102.44     5
 TOO FEW SLICES AT RAD=  100.84
 THE LOWEST FACTOR OF SAFETY FOUND WAS 2.022 AT R=  105.63

 THE MINIMUM FACTOR OF SAFETY IS  2.022 FOR X=  495.00  Y= 1480.00  R=  105.63
**** INPUT ERROR 7.16 - ATTEMPT TO READ BEYOND END OF FILE ON INPUT.
@BRKPT PRINT$
FOF:185 SCAN:24
```

11 20 F 335

END OF GRID
3 254 1625

(250, 1471)

(306, 1535)

(393, 1420)

(359, 1404)

(462, 1392)

(496, 1374)

(100, 1374)

(263, 1374)

(500, 1374)

1520
1490
1460
1430
1400
1370
1340

HARQUAHALA VALLEY WPPA Z
HARQUAHALA FRS
RAPID DRAWDOWN COMDR-1

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed
Drawn
Traced
Checked
Date
Approved by
Title
Sheet No. 1 of 1
Drawing No.

SCS-ENG-315A REV 8-75

```
@RUN S84PM,1604000101CT,SCS-AZ
DATE: 061780  TIME: 110947

>@ASG,A PRINT7.
READY
>@ED,U PRINT7.
CASE UPPER ASSUMED
ED 15R2-TUE-06/17/80-11:10:25-(0,1)
EDIT
0:>P 1 80
@QUAL  SEB
@ASG,A  *LEASESYS.
@USE  PF,*LEASESYS
@ASG,A  *LEASECDL.
@USE  SUB2,*LEASECDL
@ASG,A  *LEASEMODS.
@USE  SUB1,*LEASEMODS
@USE  E,*LEASEMODS
@ASG,A  *LEASESYSDIC.
@USE  DD3,*LEASESYSDIC
@PF.ICES,2
*************************************************
*                                               *
*          UNIVAC 1108 SERIES ICES              *
*     JUN 17, 1980              09:35:59        *
*                VERSION 1.1                    *
*                                               *
*************************************************
FILES USED BY THIS RUN
DD1:  NOT ASSIGNED, TEMPORARY USED
DD2:  NOT ASSIGNED, TEMPORARY USED
DD3:  SEB              *   LEASESYSDIC
DD4:  NOT ASSIGNED, TEMPORARY USED
LEASE * HAPOUAHALA FRS
$ ZU=3:1  ZD=2:1  TOP OF DAM ELEV IS 1419.7
$ MAX HT. IS 45 FEET  ES CREST ELEV IS 1408.4
RAPID DRAWDOWN CONDITION
 **** INPUT WARNING 7.6 'RAPID        ' IS NOT A VALID COMMAND.
$ EMBANKMENT (39-100)  FOUNDATION (39-100)
POINT 1  100 1374
2  263 1374
3  358 1408
4  393 1420
5  407 1420
6  496 1374
7  600 1374
8  359 1404
9  462 1392
LINE 1 1 2 3
  2 2 3 2
    4 1
    5 1
  5 5 9 1
  6 9 6 2
  7 6 7 3
  8 3 8 2
  9 8 9 2
 10 6 2 3
```

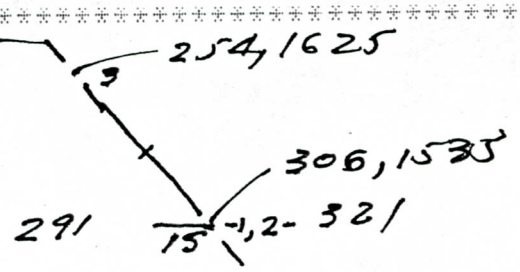
SF = 2.7

~~CHANGE~~
ENLARGE GRID &
RUN AGAIN

RUN OK

USE

```
3 132.1 100 39
PIEZ 2 1 100 1374
2 2 263 1374
2 3 358 1408
  9 359 1404
    462 1392
  6 496 1374
2 7 600 1374
NUMBER OF SLICES 30
SET YMIN 1360
RMIN TANGENT LINE 1? 2 3 4 5
 **** INPUT ERROR 7.13 - ERROR IN INTERNAL CONVERSION.
 **** OFFENDING NUMBER IS 1? ****
 **** INPUT ERROR 7.13 - ERROR IN INTERNAL CONVERSION.
 **** OFFENDING NUMBER IS 1? ****
 **** INPUT ERROR 7.13 - ERROR IN INTERNAL CONVERSION.
 **** OFFENDING NUMBER IS 1? ****
 **** INPUT ERROR 7.13 - ERROR IN INTERNAL CONVERSION.
 **** OFFENDING NUMBER IS 1? ****
 **** INPUT ERROR 7.13 - ERROR IN INTERNAL CONVERSION.
 **** OFFENDING NUMBER IS 1? ****
**** INPUT WARNING 7.7 - AN ERROR WAS DETECTED WHILE PROCESSING THIS COMMAND.
 **** INPUT WARNING 7.8 - COMMAND NOT COMPLETELY PROCESSED.
 **** SYMBOLS IN COMMAND INPUT NOT YET PROCESSED FOLLOW
  ****1? 2 3 4 5        ************************************************************
GRID 1 321 1535 2 291 1535 3 245 1640 1640 254,1625
```




$$\frac{x}{306-254} = \frac{1640-1535}{1625-1535} = \frac{105}{90}$$

$$x = \frac{(105)(52)}{90} = 60.6$$

$$x_3 = 306 - 60.6 = 245.4 \text{ say } 245$$

```
          PIEZOMETRIC SURFACE DATA

            PIEZ SURFACE NO.   2


P 81 160
          NO.   XCOORD   YCOORD
            1    100.00 1374.00
            2    263.00 1374.00
            3    358.00 1408.00
            8    359.00 1404.00
            9    462.00 1392.00
            6    496.00 1374.00
            7    600.00 1374.00

   ORDERED LINE ARRAY                                    BNDS ARRAY

   NO.   PT    PT  SOIL              X-LEFT    Y-LEFT   X-RIGHT   Y-RIGHT        SLO

PE
    1    1     2    3               100.00   1374.00    263.00   1374.00          .
000
    2    2     3    2               263.00   1374.00    358.00   1408.00          .
358
    3    3     4    1               358.00   1408.00    393.00   1420.00          .

    4    4     5    1               393.00   1420.00    407.00   1420.00          .
000
    5    5     9    1               407.00   1420.00    462.00   1392.00         -.
509
```

529

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 7 | 6 | 7 | 3 | 496.00 | 1374.00 | 600.00 | 1374.00 | . |

000

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 8 | 3 | 8 | 2 | 358.00 | 1408.00 | 359.00 | 1404.00 | -4. |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 9 | 8 | 9 | 2 | 359.00 | 1404.00 | 462.00 | 1392.00 | -. |

117

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 10 | 2 | 6 | 3 | 263.00 | 1374.00 | 496.00 | 1374.00 | . |

000

NUMBER OF TOPLINES IS 7

| FSBSHP | FSNRML | RADIUS | NO.SLCS. | X= 306.00 | Y= 1535.00 |
|---|---|---|---|---|---|
| 3.738 | 3.497 | 175.00 | 13 | | |
| 3.606 | 3.385 | 172.73 | 12 | | |
| 3.483 | 3.282 | 170.45 | 12 | | |
| 3.372 | 3.187 | 168.18 | 11 | | |
| 3.293 | 3.121 | 165.90 | 11 | | |
| 3.216 | 3.056 | 163.63 | 11 | | |
| 3.116 | 2.962 | 161.35 | 9 | | |
| 3.055 | 2.915 | 159.08 | 9 | | |
| 3.000 | 2.872 | 156.81 | 9 | | |
| 2.950 | 2.837 | 154.53 | 9 | | |
| 2.922 | 2.819 | 152.26 | 8 | | |
| 2.882 | 2.795 | 149.98 | 8 | | |
| 2.833 | 2.756 | 147.71 | 7 | | |
| 2.906 | 2.843 | 145.43 | 6 | | |
| 2.875 | 2.791 | 149.41 | 8 | | |
| 2.870 | 2.789 | 148.85 | 8 | | |
| 2.828 | 2.747 | 148.28 | 7 | | |
| 2.841 | 2.768 | 147.14 | 7 | | |
| 2.852 | 2.783 | 146.57 | 7 | | |
| 2.892 | 2.823 | 146.00 | 6 | | |
| 3.021 | 2.977 | 143.16 | 6 | | |
| 3.361 | 3.329 | 140.89 | 4 | | |
| 4.683 | 4.672 | 138.61 | 4 | | |

THE LOWEST FACTOR OF SAFETY FOUND WAS 2.828 AT R= 148.28

| FSBSHP | FSNRML | RADIUS | NO.SLCS. | X= 280.00 | Y= 1580.00 |
|---|---|---|---|---|---|
| 3.652 | 3.451 | 220.00 | 15 | | |
| 3.517 | 3.334 | 218.09 | 14 | | |
| 3.381 | 3.218 | 216.19 | 14 | | |
| 3.251 | 3.106 | 214.28 | 14 | | |
| 3.103 | 2.972 | 212.37 | 12 | | |
| 2.999 | 2.885 | 210.47 | 12 | | |
| 2.910 | 2.810 | 208.56 | 11 | | |
| 2.843 | 2.755 | 206.65 | 10 | | |
| 2.814 | 2.735 | 204.75 | 10 | | |
| 2.801 | 2.728 | 202.84 | 9 | | |
| 2.783 | 2.720 | 200.93 | 9 | | |
| 2.763 | 2.706 | 199.03 | 8 | | |
| 2.819 | 2.771 | 197.12 | 7 | | |
| 2.781 | 2.720 | 200.46 | 9 | | |
| 2.753 | 2.691 | 199.98 | 8 | | |
| 2.757 | 2.698 | 199.50 | 8 | | |
| 2.771 | 2.716 | 198.55 | 8 | | |
| 2.780 | 2.728 | 198.07 | 8 | | |
| 2.792 | 2.743 | 197.60 | 8 | | |
| 2.898 | 2.861 | 195.21 | 7 | | |

```
   3.034   3.006  193.31     6
   3.435   3.418  191.40     5
 TOO FEW SLICES AT RAD=  189.50
 THE LOWEST FACTOR OF SAFETY FOUND WAS 2.753 AT R=  199.98

 FSBSHP FSNRML RADIUS NO.SLCS. X=  254.00  Y= 1625.00
   3.867   3.668  265.00    17
0:>


P 161 240
   3.715   3.530  263.46    16
   3.600   3.431  261.92    15
   3.482   3.329  260.38    15
   3.363   3.227  258.84    15
   3.243   3.123  257.31    14
   3.122   3.019  255.77    14
   3.000   2.915  254.23    13
   2.881   2.812  252.69    13
   2.706   2.657  251.15     9
   2.731   2.688  249.61     9
   2.851   2.787  252.31    12
   2.823   2.763  251.92    12
   2.776   2.719  251.54    11
   2.711   2.664  250.77     9
   2.716   2.671  250.38     9
   2.723   2.679  250.00     9
   2.781   2.745  248.07     8
   2.846   2.817  246.53     8
   2.945   2.921  245.00     7
   3.164   3.146  243.46     6
   3.626   3.616  241.92     5
 TOO FEW SLICES AT RAD=  240.38
 THE LOWEST FACTOR OF SAFETY FOUND WAS 2.706 AT R=  251.15

 THE MINIMUM FACTOR OF SAFETY IS  2.706 FOR X=  254.00  Y= 1625.00  R=  251.15
**** INPUT ERROR 7.16 - ATTEMPT TO READ BEYOND END OF FILE ON INPUT.
@BRKPT PRINT$
EOF:187 SCAN:26
0:>
```

AZ
RIM 6-1200
STABILITY Reach 2

Hargrave FRS

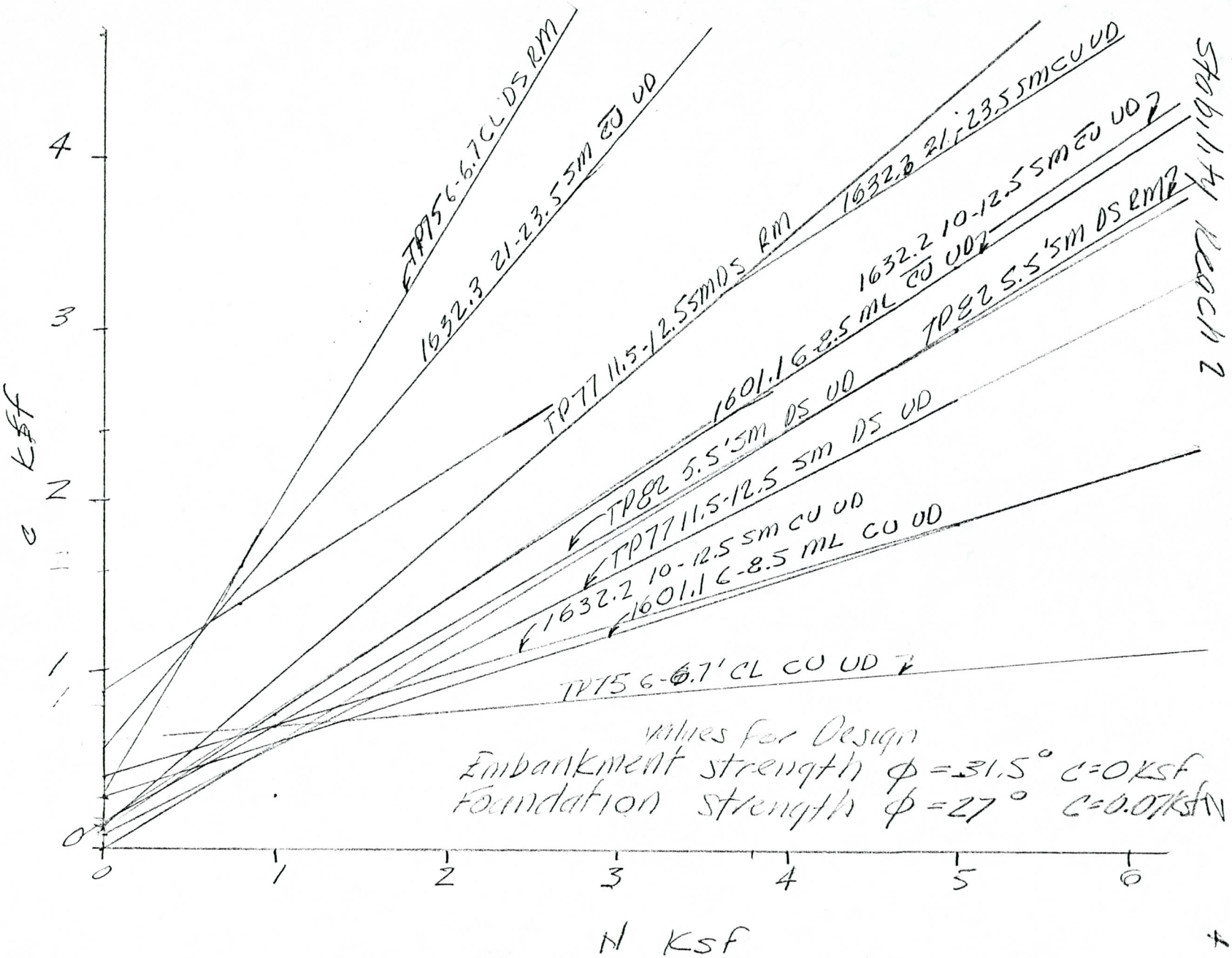
Embankment Soil properties

| STA | TP OR DH | DEPTH FT | USC SYM-BOL | $G_s$ | $\gamma_o$ PCF | $w_o$ % | $\gamma_m$* PCF | $\gamma_{sat}$* PCF | $\phi$ ° | c KSF | $\bar{\phi}$ | $\bar{c}$ KSF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 476+15 | 6 | 1.0 | ML | 2.71 | 115.1 | 12.6 | 123.1 | 128.3 | | | | |
| | | 5.0 | SC | 2.69 | 124.1 | 12.1 | 132.2 | 133.4 | | | | |
| 513+00 | 75 | 6-6.7 | CL | 2.69 | | | | | 5 | 0.58 | 29.5 | 0.30 |
| 583+00 | 7 | 1.0 | ML | 2.65 | 113.1 | 13.9 | 122.4 | 126.2 | | | | |
| | | 5.0 | ML-CL | 2.67 | 115.0 | 13.6 | 124.1 | 127.6 | | | | |
| | | 11.0 | SC | 2.63 | 126.4 | 10.8 | 133.0 | 133.7 | | | | |
| 603+00 | 77 | 4.5-5.0 | ML | 2.67 | 120.2 | 12.5 | 128.5 | 130.7 | | | | |
| 640+00 | 90 | 7.0 | ML | 2.71 | 119.0 | 13.3 | 128.1 | 130.6 | | | | |
| 663+00 | 92 | 5.5 | SM | 2.67 | 124.0 | 11.3 | 131.1 | 133.0 | | | 30 | 0.15 |
| 676+00 | 8 | 1.0 | SM | 2.62 | 121.5 | 9.5 | 126.4 | 130.7 | | | | |
| | | 5.0 | SM | 2.63 | 112.2 | 15.2 | 122.8 | 125.3 | | | | |
| | | 10.0 | SM | 2.66 | 123.0 | 11.9 | 130.6 | 132.2 | | | | |
| 693+00 | 83 | 6.0-6.5 | SM | 2.67 | 122.6 | 12.5 | 129.9 | 132.1 | | | | |

* .95 $\gamma_o$ $\gamma_{m\,AVE}$ = 127.7 pcf $\gamma_{sat\,AVE}$ = 130.3 pcf

1

1117 of 335


AZ
Run 6-18-90
Stability Analysis #25
Reach 2
Harrington
TP75 6-6.7 CL DS RM
1632.3 21-23.5 SM CU UD
TP77 11.5-12.5 SM DS RM
1632.2 21-23.5 SM CU UD
1601.1 6-8.5 ML CU UD
1632.2 10-12.5 SM CU UD
TP82 5.5'SM DS UD
TP82 5.5'SM DS RM
TP77 11.5-12.5 SM CU UD
1632.2 10-12.5 SM DS UD
1601.1 6-8.5 ML CU UD
TP75 6-6.7' CL CU UD
Values for Design
Embankment strength φ = 31.5° C = 0 Ksf
Foundation Strength φ = 27° C = 0.07 Ksf
S Ksf
N Ksf
0
1
2
3
4
5
6

AE Harquahala FRS
PJM 6-18-80
Stability Reach 2

| Station | TP or DH | Depth FT | USC Symbol | GS | 3 $\gamma_d$ pcf | 4 $\gamma_{sat}$ pcf |
|---|---|---|---|---|---|---|
| 454+50 | 70 | 6.5 | SC | 2.66* | 104.1 | 121.0 |
| | | | CC | 2.68* | 92.5 | 114.1 |
| 503+00 | TC | 8.0 | SC-CL | 2.66* | 100.3 | 118.7 |
| | | 10.0 | CL-CH | 2.66* | 104.9 | 121.5 |
| 522+50 | TB | 6.25 | CL | 2.66* | 94.4 | 115.2 |
| | | 8.6 | SC | 2.66* | 100.3 | 119.0 |
| 530+00 | 10 | 1.0 | SM | 2.66* | 93.4 | 113.7 |
| | | 5.0 | SM-SW | 2.66* | 106.9 | 122.7 |
| | | 8.5 | SM | 2.66* | 95.6 | 110.0 |
| | | 4.0+4.5 | ML | 2.65 | 100.1 | 113.5 |
| 551+00 | 15 | 6.0 | SM | 2.66* | 89.1 | 112.1 |
| | | 9.0 | ML | 2.70 | 99.9 | 119.0 |
| 573+00 | 75 | 6.35 | CL | 2.66* | 96.0 | 116.2 |
| 582+00 | 7 | 1.0 | ML | 2.65 | 90.7 | 112.9 |
| | | 5.0 | ML-CL | 2.67 | 96.2 | 116.4 |
| | | 11.0 | SC | 2.63 | 101.9 | 119.3 |
| 601+50 | 1601 | 7.25 | ML | 2.66* | 105.0 | 121.5 |
| | | 13.25 | SC-SM | 2.66* | 104.4 | 121.2 |
| | | 26.5 | SM | 2.66* | 105.0 | 121.5 |
| | | 34.25 | SM | 2.66* | 95.6 | 116.0 |
| 603+00 | 77 | 4.5-5.0 | ML | 2.66* | 95.0 | 115.6 |
| | | 12.0 | ML | 2.66* | 93.8 | 114.9 |
| 629+00 | 14 | 3.5 | ML | 2.66* | 94.5 | 115.3 |
| | | 12-13.0 | SM | 2.66* | 105.0 | 121.5 |
| | | 7.3-7.8 | ML | 2.70 | 93.4 | 115.1 |
| 642+00 | 13 | 1.0 | SM | 2.66* | 105.5 | 121.8 |
| | | 4.5-6.5 | SW-SM | 2.66* | 91.2 | 113.3 |
| | | 6.5-7.0 | SM | 2.70 | 96.3 | 116.7 |
| 632+50 | 1632 | 22.2 | ML | 2.66* | 98.1 | 117.4 |
| | | 11.25 | SM | 2.66* | 93.3 | 114.9 |
| | | 26.75 | SC | 2.66* | 100.0 | 113.6 |
| | | 34.5 | ML | 2.66* | 96.9 | 116.7 |
| 643+00 | 90 | 7.0 | ML | 2.66* | 94.0 | 115.0 |

Az Rim 6-18-90 Harquahala FRS

Stability Reach 2 4

| Station | TP or DH | Depth | USC Symbol | Gs | $\gamma_d$ pcf | $\gamma_{sat}$ pcf |
|---|---|---|---|---|---|---|
| 653+00 | 81 | 7.0 | CL-ML | 2.66* | 89.2 | 112.2 |
| | | 9.0 | CL-ML | 2.66* | 86.6 | 110.6 |
| | | 12.0 | SM | 2.66* | 92.3 | 114.0 |
| 663+00 | 82 | 9.0 | SM | 2.66* | 98.5 | 117.7 |
| 675+00 | 8 | 1.0 | SM | 2.62 | 102.6 | 119.5 |
| | | 5.0 | ML | 2.63 | 97.3 | 116.9 |
| | | 10.0 | SM | 2.66 | 105.2 | 121.6 |
| 683+00 | 83 | 6.25 | SM | 2.66* | 102.3 | 119.9 |
| 703+00 | 12 | 1.0 | SM | 2.66* | 109.4 | 124.1 |
| | | 5.0 | SM | 2.66* | 89.4 | 112.3 |
| | | 10.0 | GP-GM | 2.66* | 112.9 | 126.2 |
| | | 3.5-4.0 | SM | 2.70 | 105.6 | 122.4 |

* AVE OF RECORDED VALUES IN LIST

$\gamma_{sat\,ave} = 117.3$

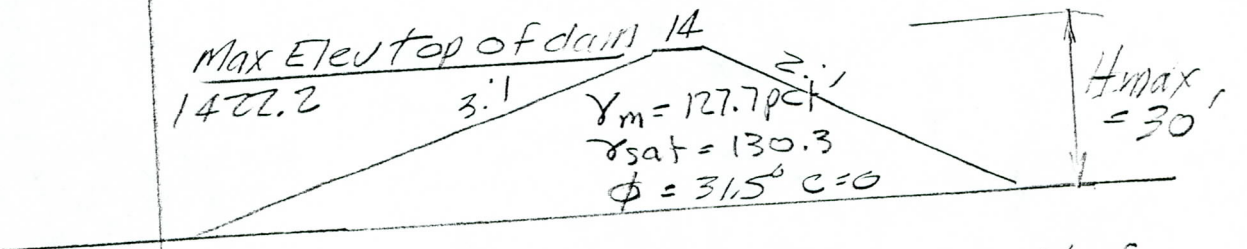
$$\% \gamma_{opt\,ave}^{sat} = \frac{.95(117.3)}{130.3}(100) = 85.5\%$$

It's reasonable to assume that after saturation of the foundation and construction of the earthfill that the material in the foundation will be of a density close to 86% of optimum. Therefore the one saturated unit wt will be used for stability analysis for the foundation materials

Harquahala FRS

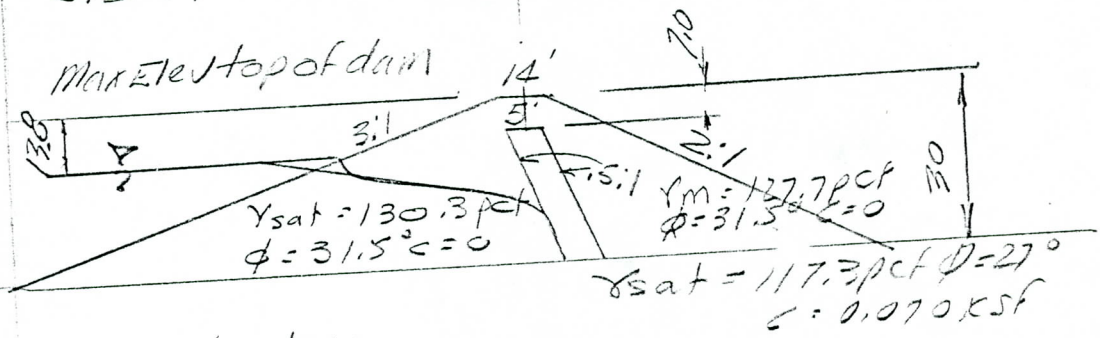
AZ
PJM 6-19-80 1 2
Stability Analysis Reach2

END CONSTRUCTION CONDITION




$\gamma_{sat}$ = 117.3 $\phi$ = 27° c = 0.070 ksf

STEADY SEEPAGE CONDITION




Phreatic Line

m = 48.6'
.3m = 14.6'
d = .3m + 3(13.8) + (7-2.5) + .5(30-7) = 72.0'
h = 30 - 13.8 = 16.2'

$$y_0 = \sqrt{h^2 + d^2} - d$$
$$= \sqrt{16.2^2 + 72^2} - 72$$
$$= 1.8'$$

$$y = \sqrt{2y_0 x + y_0^2}$$
$$= \sqrt{3.6x + 3.24}$$

For x = 12 $y = \sqrt{3.6(12) + 3.24} = 6.3'$

AZ Hanqua hala FLS
RM 6-19-80
Stability Reach 2 2 2

Infinite slope analysis for:
1. End Construction Condition
2. Steady Seepage Condition
3.
– DS slope

$$F = \frac{\tan\phi}{\tan\beta}$$

$$= \frac{\tan 31.5}{.5}$$

$$= 1.23 > 1.1 \text{ OK}$$

---

Rapid Drawdown

$$F = \frac{\tan 31.5}{1/3}$$

$$= 1.84 > 1.3 \text{ OK}$$

$\gamma_m = 122.1$ psf
$\phi = 31.5°$
$c = 0$

$H_E = \frac{122.7}{62.4} = 2.05$

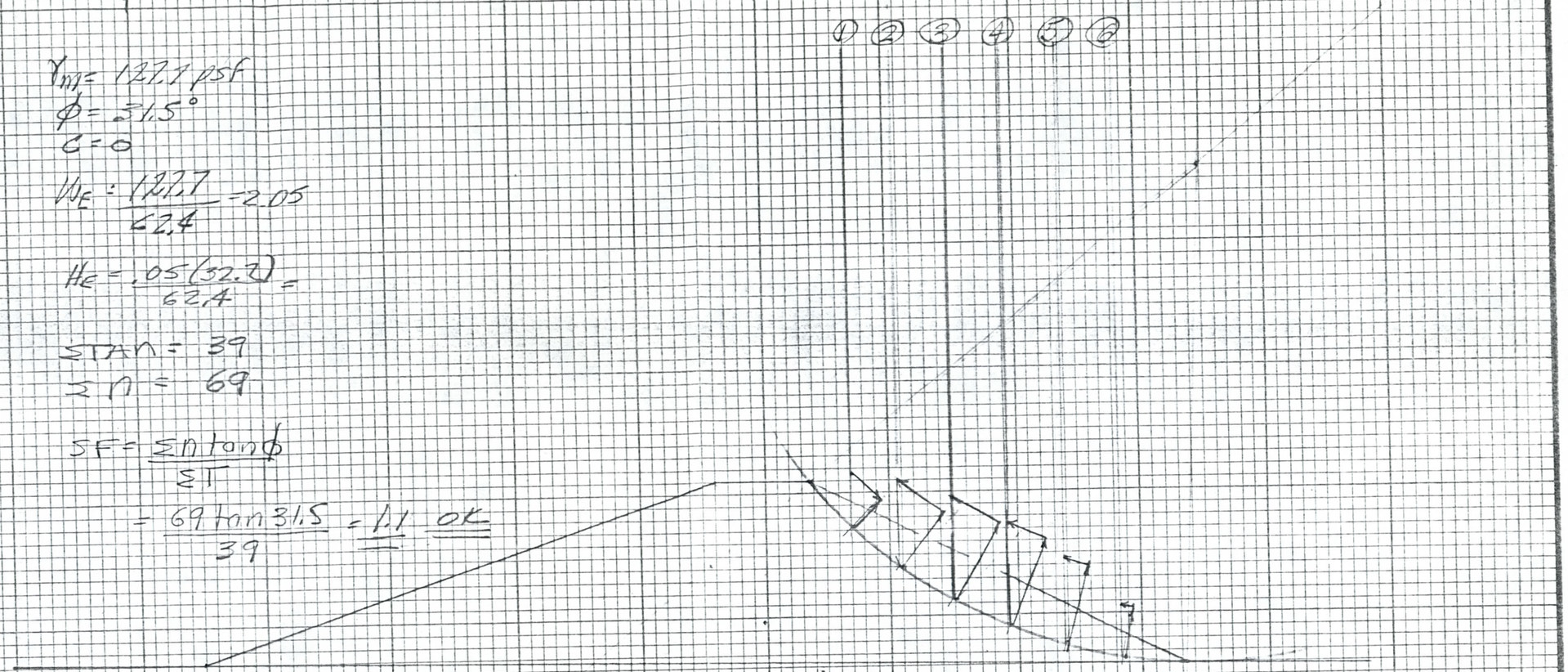
$H_E = \frac{.05(32.2)}{62.4} =$

$\Sigma T = 39$
$\Sigma n = 69$

$SF = \frac{\Sigma n \tan\phi}{\Sigma T}$

$= \frac{69 \tan 31.5}{39} = 1.1$ OK

1500
1480
1460
1440
1420
1400
1380
1360
500
100
500




HARQUAHALA VALLEY WPP AZ
HARQUAHALA FRS-R-2
STEADY SEEPAGE - SEISMIC

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed RJM Date 6-80
Drawn
Traced
Checked
Approved by
Title
Title
Sheet No. 1 of 1
Drawing No.

SCS-ENG-315A REV 8-75

DRAINFILL

STATE ARIZONA | PROJECT HARQUAHALA VALLEY

BY A.M. | DATE 19 NOV 79 | CHECKED BY | DATE | JOB NO.

SUBJECT Geology | SHEET 1 OF 2

| Group I | Group II | Group III |
|---|---|---|
| CL | SC | SW-SM |
| CL-ML | SP-SC | GM-GC |
| SC-CL | SP-SM | SP |
| SM-ML | SM-SC | SW |
| ML | GM * | GP-GM |
| SM ** | SM ** | GM * |
| ML-CL | | SM ** |
| | | GW-GM |
| | | GM * |

* soil found in two groups

** in all three groups

| D.H. | T.P. | Location S.C.S. stall | Location C.A.P. sta. | Group |
|---|---|---|---|---|
| 2 | | 621+00 | 443+65 | 2 |
| 3 | 70 | 611+50 | 453+15 | 2-1-3 |
| 5 | 71 | 591+50 | 474+15 | |
| 8 | 72 | 562+50 | 503+00 | 1 |
| 10 | 73 | 542+25 | 522+50 | 1-2 |
| 11 | | 532+00 | 533+00 | 1-2 |
| 14 | 74 | 502+00 | 563+00 | 3-2-1 |
| 15 | 75 | 492+00 | 573+00 | 1-2-**1 |
| 16 | | 482+00 | 583+00 | 2 |
| 17 | 76 | 472+00 | 593+00 | 1-3 |
| 18 | 77 | 462+00 | 603+00 | **1-2 |
| 19 | 78 | 452+00 | 613+00 | **1 |
| 21 | 79 | 432+50 | 633+00 | 1-**1 |
| 22 | 80 | 422+50 | 643+00 | 1-**1 |

(1 Preliminary design Stationing.)

COMPUTATION SHEET
SCS-ENG-523 Rev. 8-69

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

2335 335

| STATE | | PROJECT | | |
|---|---|---|---|---|
| ARIZONA | | HARQUAHALA VALLEY | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. |
| A.M. | 19 Nov. 79 | | | |
| SUBJECT | | | | SHEET 2 OF 2 |
| Geology | | | | |

| | | LOCATION | | | |
|---|---|---|---|---|---|
| D.H. | T.P. | S.C.S. Sta | C.A.P. sta. | Group | |
| 23 | 81 | 412+50 | 653+00 | 3-1-2 | |
| 24 | 82 | 402+50 | 663+00 | **1 | |
| 26 | 83 | 382+50 | 683+00 | **1 | |
| 32 | 84 | 322+25 | 742+50 | *2-3 | |
| 33 | | 313+00 | 752+50 | 3 | |
| 44 | 85 | 203+00 | 861+50 | *2-3 | |
| 46 | 86 | 182+00 | 882+00 | *2 | |
| 67A | | 128+00 | 936+00 | **1 | 250' left |
| 67B | | | | *2 | 130' left |
| 56 | | 81+00 | 982+50 | 3 | |
| 59 | | 51+50 | 1013+00 | *2 | |

SCS–ENG–353A
Rev. 11–71

All samples

126 of 335

LABORATORY NO.

| MATERIALS TESTING REPORT | U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE | SOIL CLASSIFICATION |
|---|---|---|

| PROJECT and STATE | SAMPLE LOCATION |
|---|---|
| Harquahala Valley Ariz | |

| FIELD SAMPLE NO. | DEPTH | GEOLOGIC ORIGIN |
|---|---|---|
| | | |

| TYPE OF SAMPLE | TESTED AT | APPROVED BY | DATE |
|---|---|---|---|
| | | | |

| SYMBOL | DESCRIPTION |
|---|---|
| | |

GRAIN SIZE DISTRIBUTION

$D_{10}$ | $D_{15}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{85}$ | $D_{MAX}$ | $C_u$ | $C_c$

FINES | SANDS | GRAVELS | COBBLES

SIEVE OPENING, (mm)

U.S STANDARD SIEVE SIZE

(.0074) #200 | (.0105) #140 | (.0149) #100 | (.0297) #50 | (.0250) #60 | (.0420) #40 | (.0595) #30 | (.0841) #20 | (.119) #16 | (2.00) #10 | (2.36) #8 | (4.76) #4 | (9.51) 3/8" | (12.7) 1/2" | (19.0) 3/4" | (25.4) 1" | (38.1) 1 1/2" | (50.8) 2" | (76.1) 3" | (152.2) 6" | (304.4) 12"

GRAIN SIZE IN MILLIMETERS

PERCENT FINER BY DRY WEIGHT

| UNDISTURBED CONDITION | | | SOLUBLE SALTS % | SHRINKAGE LIMIT % | ATTERBERG LIMITS | | | | | | | | SPECIFIC GRAVITY ($G_s$) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MOISTURE % | DRY UNIT WEIGHT g/cc | DRY UNIT WEIGHT pcf | | | NATURAL MOISTURE LL | NATURAL MOISTURE PI | AIR DRY LL | AIR DRY PI | OVEN DRY LL | OVEN DRY PI | | | (+) #4 | (–) #4 |
| | | | | | | | | | | | | | | |

REMARKS:

SCS-ENG-353A
Rev. 11-71

Reach 2

LABORATORY NO. _____

| MATERIALS TESTING REPORT | U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE | SOIL CLASSIFICATION |
|---|---|---|

PROJECT and STATE: Harquahala Valley Arizona

SAMPLE LOCATION: ℄ Dam ℄ Floodway

FIELD SAMPLE NO. | DEPTH | GEOLOGIC ORIGIN

TYPE OF SAMPLE | TESTED AT: SH&B | APPROVED BY | DATE: 8 Nov. 79

SYMBOL: CL SM-ML SC-CL CL-ML ML SM | DESCRIPTION: GROUP 1

GRAIN SIZE DISTRIBUTION

$D_{90}$ $D_{15}$ $D_{50}$ $D_{30}$ $D_{60}$ $D_{85}$ $D_{MAX}$ $C_u$ $C_c$

COBBLES | GRAVELS | SANDS | FINES

SIEVE OPENING, (mm)

U.S. STANDARD SIEVE SIZE

12" (304.4) 6" (152.2) 3" (76.1) 2" (50.8) 1½" (38.1) 1" (25.4) ¾" (19.0) ½" (12.7) ⅜" (9.51) #4 (4.76) #8 (2.38) #10 (2.00) #16 (1.19) #20 (0.841) #30 (0.595) #40 (0.420) #50 (0.297) #60 (0.250) #100 (0.149) #140 (0.105) #200 (0.074)

100 90 80 70 60 50 40 30 20 10 0

PERCENT FINER BY DRY WEIGHT

4000 3000 2000 1000 500 400 300 200 100 50 40 30 20 10 5 4 3 2 1 0.5 0.4 0.3 0.2 0.1 0.05 0.04 0.03 0.02 0.01 0.005 0.004 0.003 0.002 0.001 0.0005 0.0004 0.0003 0.0002 0.0001

GRAIN SIZE IN MILLIMETERS

UNDISTURBED CONDITION: MOISTURE (%) | DRY UNIT WEIGHT (g/cc, pcf)

SHRINKAGE LIMIT (%)

SOLUBLE SALTS (%)

ATTERBERG LIMITS: NATURAL MOISTURE (LL, PI) | AIR DRY (LL, PI) | OVEN DRY (LL, PI)

SPECIFIC GRAVITY ($G_s$): (+) #4 | (-) #4

REMARKS:

USDA-SCS-HYATTSVILLE MD 1968

GPO : 1971 O - 450-349

SCS–ENG–353A
Rev. 11–71

Reach 1 & 2

128 of 335

LABORATORY NO.

| MATERIALS TESTING REPORT | U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE | SOIL CLASSIFICATION |
|---|---|---|

PROJECT and STATE: Harquahala Valley Arizona

SAMPLE LOCATION: E Dam & Floodway

FIELD SAMPLE NO.

DEPTH

GEOLOGIC ORIGIN

TYPE OF SAMPLE

TESTED AT: SH & B

APPROVED BY

DATE: 15 Nov. 79

SYMBOL: SC SP-SC SP-SM SM-SC SM GM

DESCRIPTION: GROUP 2

GRAIN SIZE DISTRIBUTION

$C_c$ | $C_u$ | $D_{MAX}$ | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$

COBBLES | GRAVELS | SANDS | FINES

SIEVE OPENING, (mm)

U.S. STANDARD SIEVE SIZE

GRAIN SIZE IN MILLIMETERS

PERCENT FINER BY DRY WEIGHT

UNDISTURBED CONDITION: MOISTURE %; DRY UNIT WEIGHT g/cc, pcf

SHRINKAGE LIMIT %

SOLUBLE SALTS %

ATTERBERG LIMITS: NATURAL MOISTURE LL, PI; AIR DRY LL, PI; OVEN DRY LL, PI

SPECIFIC GRAVITY ($G_s$): (+) #4; (–) #4

REMARKS:

USDA-SCS-HYATTSVILLE MD 1968

GPO : 1971 O - 450-349

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SCS—ENG—353A
Rev. 11—71

Bench 1

LABORATORY NO. _____

| MATERIALS TESTING REPORT | U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE | SOIL CLASSIFICATION |
|---|---|---|

PROJECT and STATE: Harquahala Valley Arizona

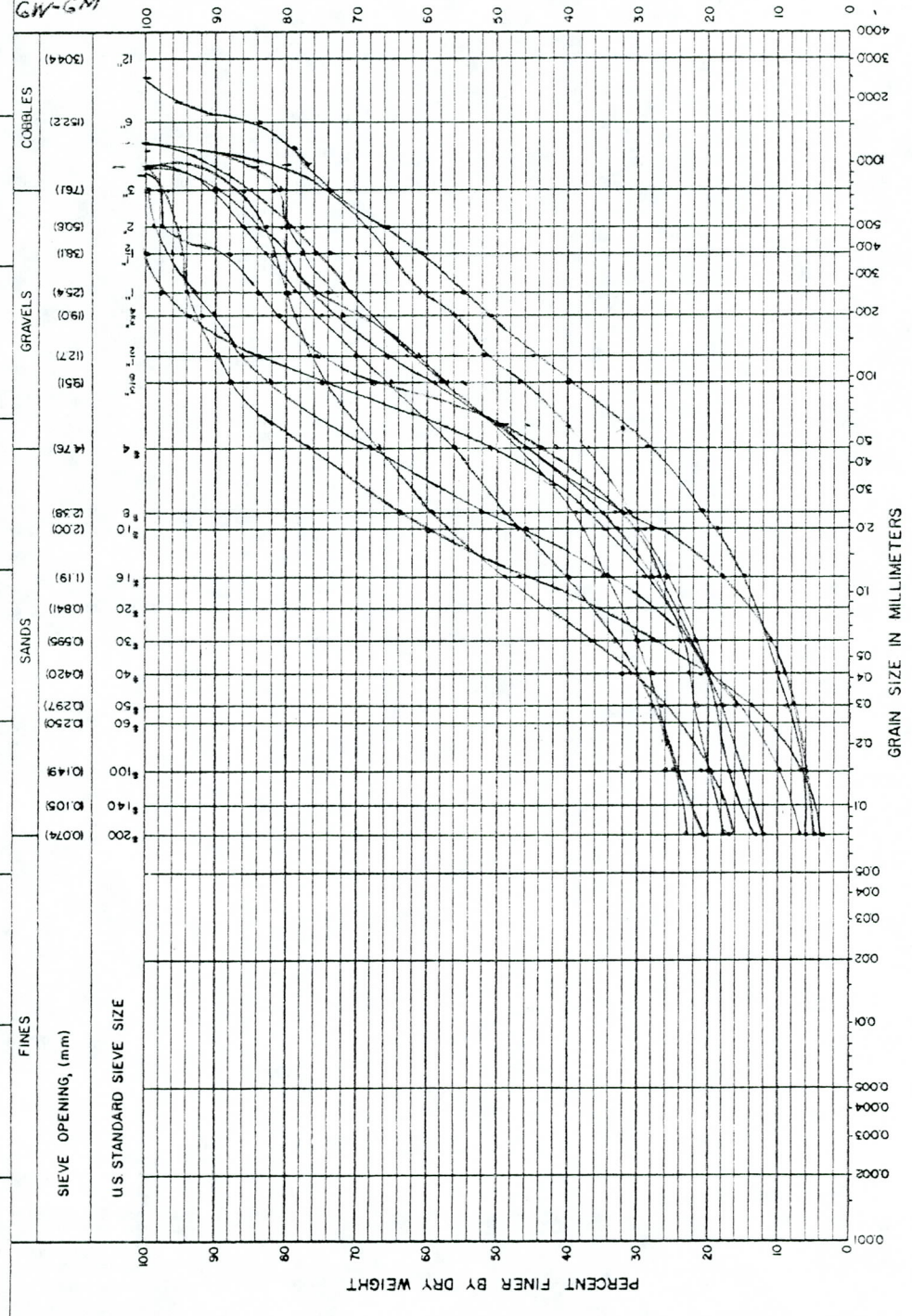
SAMPLE LOCATION: E Dam & Floodway

FIELD SAMPLE NO. | DEPTH | GEOLOGIC ORIGIN

TYPE OF SAMPLE | TESTED AT: SHE B | APPROVED BY | DATE: 15 NOV. 79

SYMBOL: SW-SM, GM-GC, SP, SM, SW, GP-GM, GM, GW-GM | DESCRIPTION: GROUP 3

GRAIN SIZE DISTRIBUTION




$C_c$ | $C_u$ | $D_{MAX}$ | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$

UNDISTURBED CONDITION: MOISTURE (%) | DRY UNIT WEIGHT (g/cc, pcf)

SHRINKAGE LIMIT (%)

SOLUBLE SALTS (%)

ATTERBERG LIMITS: NATURAL MOISTURE (LL, PI) | AIR DRY (LL, PI) | OVEN DRY (LL, PI)

SPECIFIC GRAVITY ($G_s$): (+) #4 | (−) #4

REMARKS:

USDA-SCS-HYATTSVILLE, MD. 1968

GPO : 1971 O - 450-349

SCS-ENG-353 (REV. 3-70)
FILE CODE ENG-22

Embankment Drain Fill Quachz

LAB 130 of 335

# MATERIALS TESTING REPORT

## U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE

# SOIL CLASSIFICATION

PROJECT and STATE: HARQUAHALA VALLEY PPP AZ

FIELD SAMPLE NO.:

DEPTH:

GEOLOGIC ORIGIN:

SAMPLE LOCATION:

TYPE OF SAMPLE:

TESTED AT:

APPROVED BY:

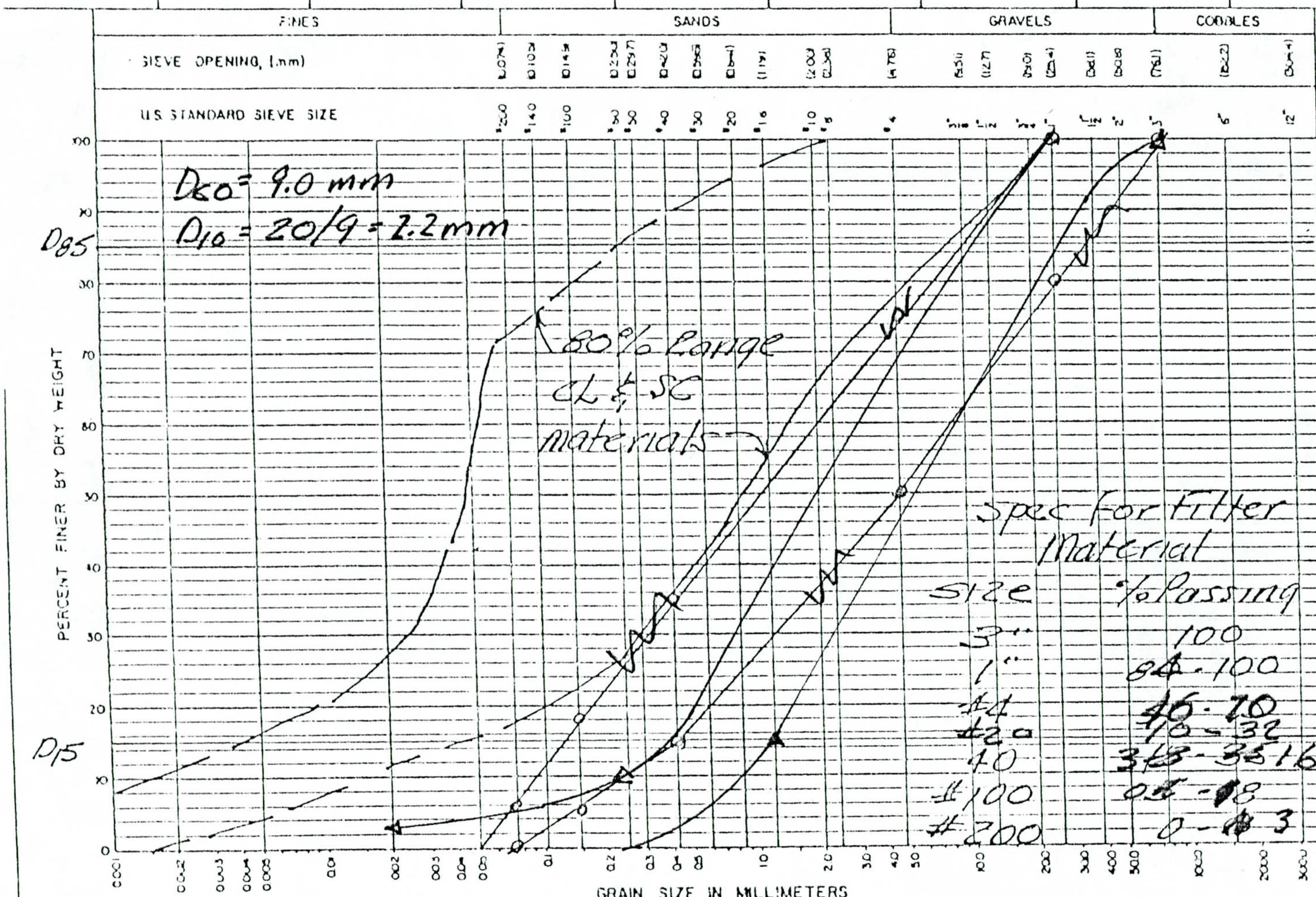
DATE: 7-23-80 / 6-23-80

SYMBOL:

DESCRIPTION:

## GRAIN SIZE DISTRIBUTION

| $D_{10}$ | $D_{15}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{85}$ | $D_{MAX}$ | $C_u$ | $C_c$ |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |




| SPECIFIC GRAVITY ($G_s$) | | ATTERBERG LIMITS | | | | | | SOLUBLE SALTS | SHRINKAGE LIMIT | UNDISTURBED CONDITION | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | NATURAL MOISTURE | | AIR DRY | | OVEN DRY | | | | MOISTURE | DRY UNIT WEIGHT |
| (-) #4 | (+) #4 | LL | PI | LL | PI | LL | PI | % | % | % | g/cc pcf |

REMARKS:

SCS–ENG–353A
Rev. 11–71

Toe Drains

LABORATORY NO. _____

| MATERIALS TESTING REPORT | U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE | SOIL CLASSIFICATION |
|---|---|---|

PROJECT and STATE: AZ Harquahala FRS Drain Fill

SAMPLE LOCATION: Sta 717+00 to 1054+00

| FIELD SAMPLE NO. | DEPTH | GEOLOGIC ORIGIN |
|---|---|---|
| TYPE OF SAMPLE | TESTED AT | APPROVED BY / DATE |

| SYMBOL | DESCRIPTION |
|---|---|

GRAIN SIZE DISTRIBUTION

$D_{90}$ $D_{15}$ $D_{30}$ $D_{50}$ $D_{60}$ $D_{85}$ $D_{MAX}$ $C_u$ $C_c$

COBBLES | GRAVELS | SANDS | FINES

SIEVE OPENING, (mm)

U.S. STANDARD SIEVE SIZE

12" (304.4) 6" (152.2) 3" (76.1) 2" (50.8) 1½" (38.1) 1" (25.4) ¾" (19.0) ½" (12.7) ⅜" (9.51) #4 (4.76) #6 (3.36) #10 (2.00) #16 (1.19) #20 (.0841) #30 (.0599) #40 (.0420) #50 (.0297) #60 (.0250) #100 (.0149) #140 (.0105) #200 (.0074)

100 90 80 70 60 50 40 30 20 10 0

PERCENT FINER BY DRY WEIGHT

4000 3000 2000 1000 500 400 300 200 100 50 40 30 20 10 5 4 3 2 1 .5 .4 .3 .2 .1 .05 .04 .03 .02 .01 .005 .004 .003 .002 .001 .0005 .0004 .0003 .0002 .0001

GRAIN SIZE IN MILLIMETERS

Hot 233

Gravel 23.4%
Sand 74.2%
Fines 2.4%

3" 100
¾" 50-100
#4 25-60
#40 5-30
#200 0-12

| UNDISTURBED CONDITION | | |
|---|---|---|
| MOISTURE % | DRY UNIT WEIGHT g/cc | pcf |
| | | |

| SOLUBLE SALTS % | SHRINKAGE LIMIT % |
|---|---|
| | |

ATTERBERG LIMITS

| NATURAL MOISTURE LL | NATURAL MOISTURE PI | AIR DRY LL | AIR DRY PI | OVEN DRY LL | OVEN DRY PI |
|---|---|---|---|---|---|
| | | | | | |

SPECIFIC GRAVITY ($G_s$)

| (–) #4 | (+) #4 |
|---|---|
| | |

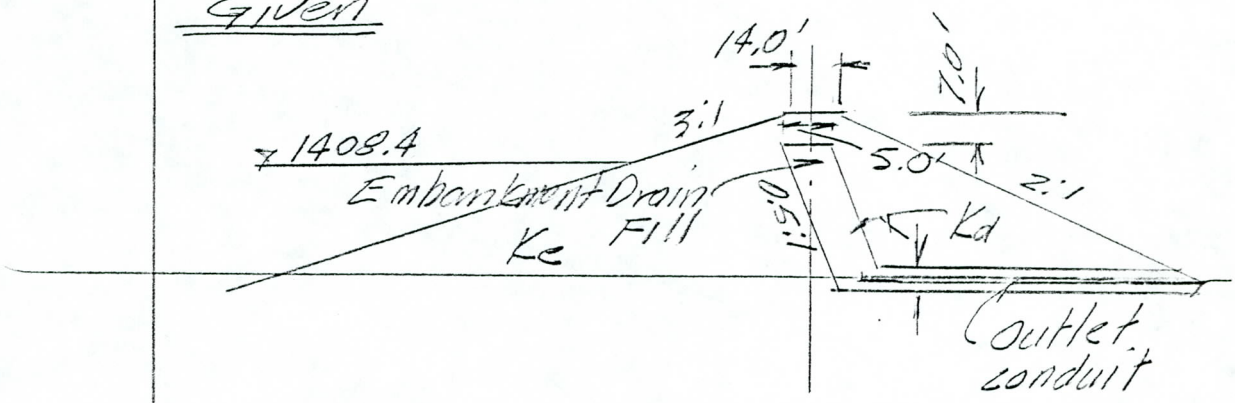
REMARKS:

AE
RJM 7-1-80

Harquahala FRS

1 2

Given




Find a) outlet conduit type, size & spacing
b) outlet drain fill thickness & gradation

Solution

a) Outlet conduit

$q = K y_o$

where $y_o = 18'$ see stability analysis steady seepage condition

$K_e = 0.0010$ value assigned to fpd GM & SM in foundation design Reach 1 p 7 of 32

$q = (0.0010)(1.8)(0.0000115T)$
$= 2.08 \times 10^{-5}$ cfs/ft

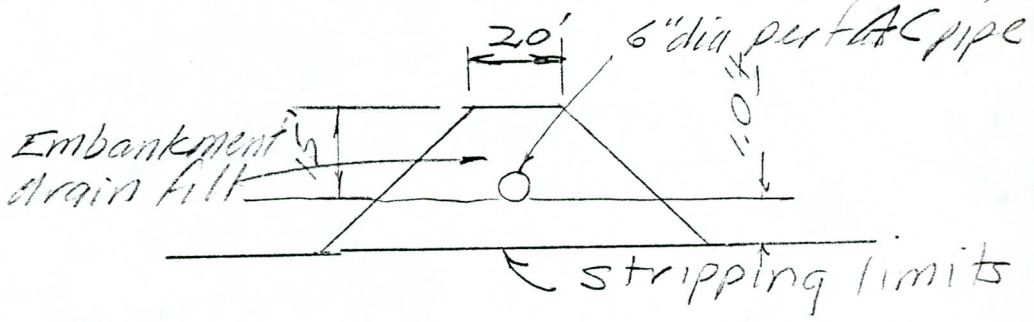
AE Harquahala FRS
RJM 7-1-80

TRY 6" Dia perf asbestos pipe @ 400' c.c.

$Q_{req'd} = 400(2.03 \times 10^{-3}) = 8.32 \times 10^{-6}$ cfs

$Q_{act} = 5400 \times 10^{-6}$ cfs/ft @ $h = 0.5'$ OK

Use Embankment drain fill for conduit envelope




CROSS SECTION
Embankment drain fill Outlet

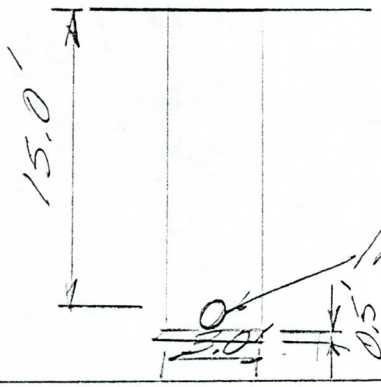
Note: Embankment drain fill outlet shall be installed at 400' intervals beginning at Sta 452+00 and ending at Sta 716+00

AZ
RIM 7-25-80
Pipe Strength

Harquahala #25

1 1

Given




$\gamma_m = 125.6$ pcf

Determine: Rigid pipe strength required.

Solution:

a) From Design Manual Concrete pipe

Table 15 p102 for sand & gravel @ 100 pcf

$W_d = 2203 \times 1.256 = 3770$ #/LF

For a class D bedding $LF = 1.1$

$W_E$ = reqd pipe @ H = 15'

$D_{0.01} = \frac{W_E}{L_f \times D} \times F.S$

$= \frac{2770}{1.1\,(1)} \times 1.0 =$ _____ #/L.F.

# EMERGENCY SPILLWAY STRUCTURAL DESIGN

COMPUTATION SHEET

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE



| STATE Arizona | PROJECT Harquahala Valley WP | | | |
|---|---|---|---|---|
| BY W.E. Brown | DATE 10-11-79 | CHECKED BY [illegible] | DATE 12-14-79 | JOB NO. EDS |
| SUBJECT Emergency Spillway Design Parameters | | | | SHEET / NO. 65 |

## DETERMINATION OF SOIL-MOISTURE RELATIONS

### LABORATORY TEST VALUES

SM 2.687 TP 80 @ 7' 2.694 TP 77 @ 12' 2.711 TP 75 6'

Sample No. TP 83 6.0'-6.5' $G_s$ = 2.67 g/c.c. Assumed

Compaction: ☒ Std. ☐ Mod. $\gamma_w$ = 62.4 #/ft.³

@ Opt.: $\gamma_d$ = 122.6 #/ft.³ (max. dry density)

$w$ = 11.5 %

| | Moist or Opt. | Sat. |
|---|---|---|
| $\phi$ | | |
| K | | |
| $\mu$ | | |
| $k_\mu$ | | |

EDS FWS Table 2.1
Dense Silty Sand $\phi_m$ 110-150
$\phi_b$ 70-88

### COMPUTED SOIL VALUES

(Earth Fill Class A = 95 % max.)

Compacted moist wt. ($\gamma_m$).

$\gamma_d$ = % max. ($\gamma_d$ max.) = 0.95 x 122.6 #/ft.³ = $\gamma_d$ 116.5 #/ft.³ (14.6)

$w$ @ Opt. (or other) = 11.5 % = 0.115

$\gamma_m = \gamma_d (1+w)$ = 116.5 #/ft.³ x 1.115 = $\gamma_m$ 129.9 #/ft.³

Use $\gamma_m$ = 130

133.5/SML 14.5% moisture use @ 95% Std.

Volume occupied by soil ($V_s$) 0.69

$V_s = \frac{\gamma_d}{G_s \cdot \gamma_w} = \frac{116.5 \text{ \#/ft.}^3}{(2.67)(62.4 \text{ \#/ft.}^3)} = 0.7$ ft.³

Volume occupied by water @ sat. ($V_v$). 0.31

$V_v = 1.0 - V_s = 1.0 - 0.7$ ft.³ = 0.3 ft.³

Weight of water @ sat. ($W_w$).

$W_w = V_v \cdot 62.4$ #/ft.³ = 0.3 x 62.4 #/ft.³ = 18.7 #/ft.³

Use $\gamma_{sat}$ = 136

Compacted saturated wt. ($\gamma$ sat.).

$\gamma_{sat.} = W_w + \gamma_d$ = 18.7 #/ft.³ + 116.5 #/ft.³ = $\gamma_{sat.}$ = 135.2 #/ft.³

Buoyant wt. ($\gamma_b$)

$\gamma_b = \gamma_{sat.} - \gamma_w$ 135.2 #/ft.³ − 62.4 #/ft.³ = $\gamma_b$ = 72.8 #/ft.³

Use $\gamma_b$ = 73

Drawing No. 3-L-45932

COMPUTATION SHEET

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE



| ST. Arizona | PROJECT Harquahala Valley WP | | | |
|---|---|---|---|---|
| BY W.E. Payne | DATE 10-11-79 | CHECKED BY | DATE | JOB NO. EAS |
| SUBJECT Emergency Spillway Design Parameters | | | | SHEET NO. 6.5 |

## DETERMINATION OF SOIL-MOISTURE RELATIONS

### LABORATORY TEST VALUES

GM
TP 84

Sample No. 0-8.0 $G_s$ = 2.67 g/c.c. Assumed

Compaction: ☐ Std. ☐ Mod. $\gamma_w$ = 62.4 #/ft.³

@ Opt.: $\gamma_d$ = 101.9 #/ft.³ (max. dry density)

$w$ = 2.6 %

| | Moist or Opt. | Sat. |
|---|---|---|
| $\phi$ | | |
| K | | |
| $\mu$ | | |
| $k_\mu$ | | |

### COMPUTED SOIL VALUES

(Earth Fill Class A = 95 % max.)

Compacted moist wt. ($\gamma_m$).

$\gamma_d$ = % max. ($\gamma_d$ max.) = 0.95 x 101.9 #/ft.³ = $\gamma_d$ 96.8 #/ft.³

$w$ @ Opt. (or other) = 2.6 % = 0.026

$\gamma_m = \gamma_d (1+w)$ = 96.8 #/ft.³ x 1.026 = $\gamma_m$ 99.3 #/ft.³

Volume occupied by soil ($V_s$)

$V_s = \frac{\gamma_d}{G_s \cdot \gamma_w} = \frac{96.8 \text{ \#/ft.}^3}{(2.67)(62.4 \text{ \#/ft.}^3)} = 0.58$ ft.³

Volume occupied by water @ sat. ($V_v$).

$V_v = 1.0 - V_s = 1.0 - 0.58$ ft.³ = 0.42 ft.³

Weight of water @ sat. ($W_w$).

$W_w = V_v \cdot 62.4$ #/ft.³ = 0.42 x 62.4 #/ft.³ = 26.1 #/ft.³

Compacted saturated wt. ($\gamma$ sat.).

$\gamma_{sat.} = W_w + \gamma_d$ = 26.1 #/ft.³ + 96.8 #/ft.³ = $\gamma$sat. = 122.9 #/ft.³

Buoyant wt. ($\gamma_b$)

$\gamma_b = \gamma_{sat.} - \gamma_w$ = 122.9 #/ft.³ − 62.4 #/ft.³ = $\gamma_b$ = 60.5 #/ft.³

Drawing No. 3-L-45932

Use Values from Sheet 1

COMPUTATION SHEET

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SOIL CONSERVATION SERVICE



| STATE | PROJECT | | |
|---|---|---|---|
| Arizona | Harquahala Valley WP | | |
| BY / DATE | CHECKED BY / DATE | JOB NO. | |
| W.E. Payne 11-13-79 | 12-17-79 | F.R.S. | |
| SUBJECT | | SHEET | OF |
| Emergency Spillway Design | | 52 | 65 |

# INPUT DATA:

ALPHANERIC INFORMATION — CHANNELS (TR-50)

| |
|---|
| HARQUAHALA VALLEY EM. SPWY CHANNEL |
| 16FT. WALL 12FT. BACKFILL |

16th Preliminary

| B | HT | HB | DESIGN | DEFAULT1 | DEFAULT2 | DEFAULT3 | |
|---|---|---|---|---|---|---|---|
| 150. | 16. | 12. | 2. | 1. | 1. | 1. | ——— |
| HW1 | HW2 | HWP | GMOIST | GSAT | KO1 | KO2 | FLOATR |
| 1. | 0. | 1. | 130. | 136. | 0.7 | 0.35 | 2.0 |
| MAXFTG | JOINTS | MFOUND | ——— | ——— | ——— | ——— | ——— |
| 40. | 40. | 500000. | | | | | |
| CFSC | CFSS | KPASS | ——— | ——— | ——— | ——— | ——— |
| 0.45 | 0.55 | 1.43 | | | | | |

Use for final design

COMPUTATION SHEET

SCS–ENG–523 Rev. 8–69

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

138-I-335

| STATE | | PROJECT | | | |
|---|---|---|---|---|---|
| Arizona | | Harquahala Valley W.P. | | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. | |
| W.E. Payne | 11-13-79 | SMW | 12-17-79 | E.R.S. | |
| SUBJECT | | | | SHEET | OF |
| Emergency Spillway Design | | | | 53 | 65 |

## OUT PUT DATA:

ECTANGULAR STRUCTURAL CH
CROSS SECTION DESIGN
ELASTIC ANALYSIS AND WORKING STRESS DESIGN ARE USED

SPECIAL DESIGN PREPARED BY THE DESIGN UNIT AT GLENN DALE, MD.
FOR

#16

HARQUAHALA VALLEY EM.SPWY.CHANNEL
17.889 FT WALL

DESIGN PARAMETERS

B=150.00 HW1= 1.00 KO1= 0.70 FLOATR= 2.00 MFOUND= 50000

0.

HT= 16.00 HW2= 0.0 KO2= 0.35 JOINTS= 40.00 GMOIST= 13

0.

HB= 12.00 HWP= 1.00 KPASS= 1.43 MAXFTG= 40.00 GSAT= 13

5.

CFSC= 0.45 CFSS= 0.55

DESIGN OF SPECIFIED TYPE FOLLOWS

TYPE T3F STRUCTURAL CHANNEL - TRIAL VALUES

X= 13.00 TP= 11.00 XP=124.00
TT= 10.00 TB= 14.00 TS= 15.00 FTG PROJ= 1.00 QUANT= 6.799

TYPE T3F STRUCTURAL CHANNEL - DETAIL DESIGN

X= 13.00 TP= 11.00 XP=124.00
TT= 10.00 TB= 14.00 TS= 15.00 FTG PROJ= 1.00 QUANT= 6.799

COMPUTATION SHEET

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U. S. DEPARTMENT OF AGRICULTURE

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| | | | | | |
|---|---|---|---|---|---|
| STATE Arizona | | PROJECT Harquahala Valley WP | | | |
| BY W.E. Payne | DATE 11-13-79 | CHECKED BY [illegible] | DATE 12-17-79 | JOB NO. F.R.S. | |
| SUBJECT Emergency Spillway Design | | | | SHEET 54 OF 65 | |

# OUTPUT DATA CONT'D

STEEL REQUIREMENTS

WALL

| | | | |
|---|---|---|---|
| A( 1)= | 0.24 | S( 1)= | 18.00 |
| A( 2)= | 0.24 | S( 2)= | 18.00 |
| A( 3)= | 0.26 | S( 3)= | 18.00 |
| A( 4)= | 0.26 | S( 4)= | 18.00 |
| A( 5)= | 0.29 | S( 5)= | 18.00 |
| A( 6)= | 0.14 | S( 6)= | 18.00 |
| A( 7)= | 0.84 | S( 7)= | 18.00 |
| A( 8)= | 0.43 | S( 8)= | 18.00 |
| A( 9)= | 1.69 | S( 9)= | 18.00 |
| A(10)= | 1.48 | S(10)= | 17.55 |

BASE

| | | | |
|---|---|---|---|
| A(11)= | 0.18 | S(11)= | 18.00 |
| A(12)= | 0.18 | S(12)= | 18.00 |
| A(13)= | 0.18 | S(13)= | 18.00 |
| A(14)= | 0.18 | S(14)= | 18.00 |
| A(15)= | 0.18 | S(15)= | 18.00 |
| A(16)= | 0.18 | S(16)= | 18.00 |
| A(17)= | 1.96 | S(17)= | 18.00 |
| A(18)= | 1.68 | S(18)= | 18.00 |
| A(19)= | 0.88 | S(19)= | 18.00 |
| A(20)= | 0.43 | S(20)= | 18.00 |
| A(21)= | 0.36 | S(21)= | 18.00 |
| A(22)= | 0.18 | S(22)= | 18.00 |

KEY WALL NOT REQUIRED

PAVEMENT SLAB

| | | | |
|---|---|---|---|
| A(23)= | 0.26 | S(23)= | 18.00 |
| A(24)= | 0.13 | S(24)= | 18.00 |
| A(25)= | 0.26 | S(25)= | 18.00 |
| A(26)= | 0.13 | S(26)= | 18.00 |
| A(27)= | 0.35 | S(27)= | 18.00 |
| A(28)= | 0.18 | S(28)= | 18.00 |

COMPUTATION SHEET

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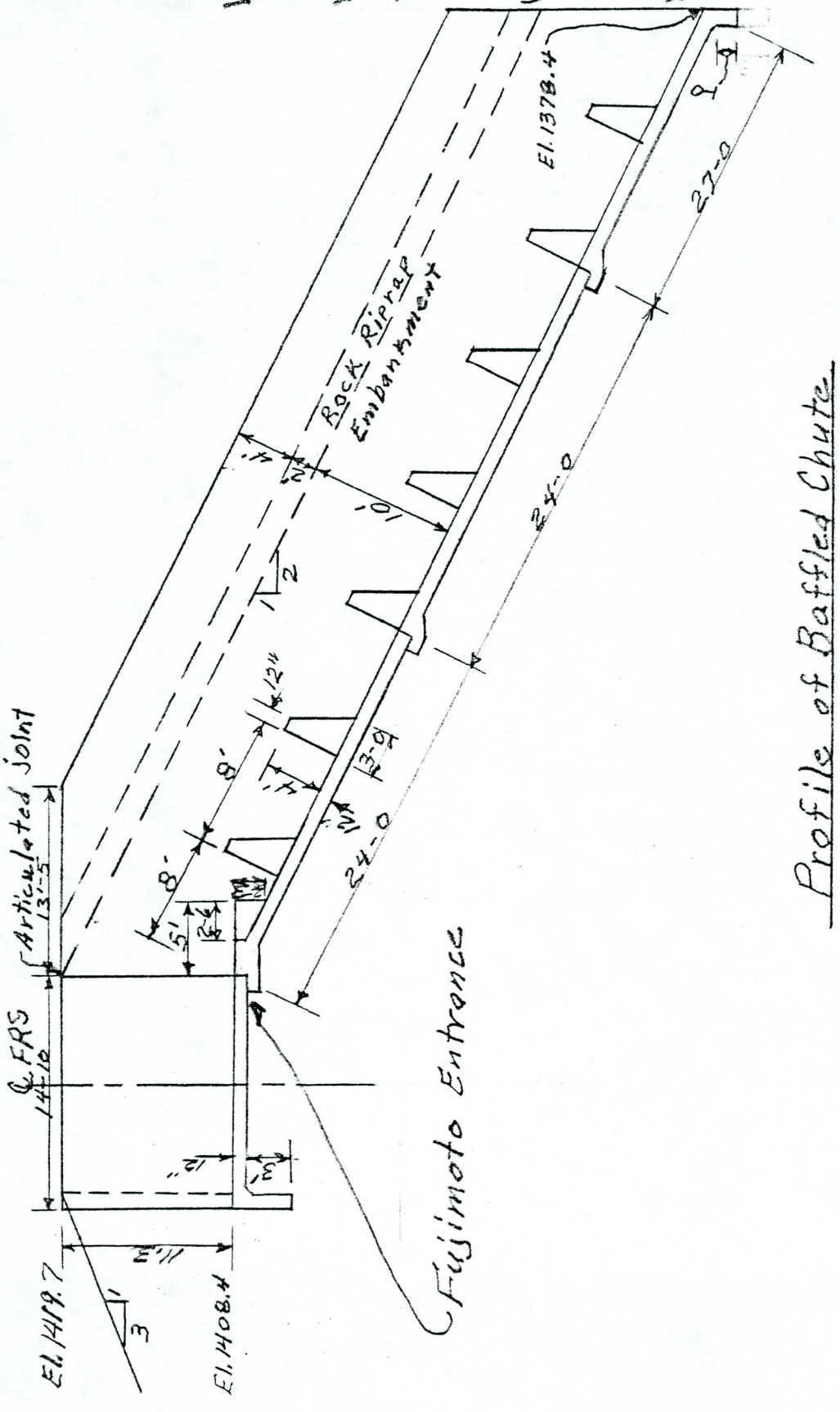
| STATE | | PROJECT | | |
|---|---|---|---|---|
| Arizona | | Harquahala Valley W.P. | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. |
| W.E. Payne | 12-19-79 | [illegible] | 12-79 | F.R.S |

SUBJECT Emergency Spillway Design — SHEET 57 OF 65



COMPUTATION SHEET

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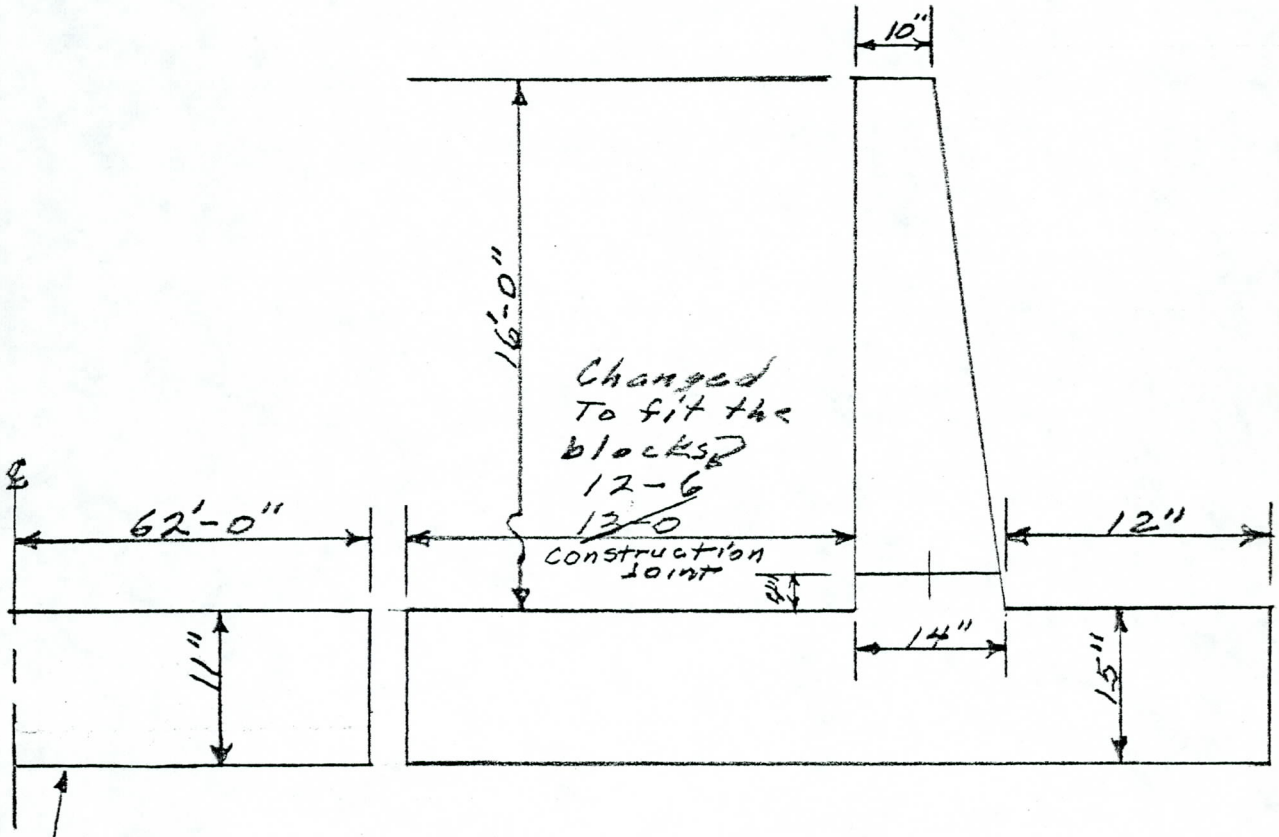
| STATE | | PROJECT | | |
|---|---|---|---|---|
| Arizona | | Harquahala Valley W.P. | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. |
| W.E. Payne | 12-13-79 | [illegible] | 12-79 | EAS |

SUBJECT Emergency Spillway Design — SHEET 58 OF 65

Half Section of Baffled Chute




Construction joints to be at 25' to fit the blocks longitudinally. 12.5' from each side wall.

COMPUTATION SHEET

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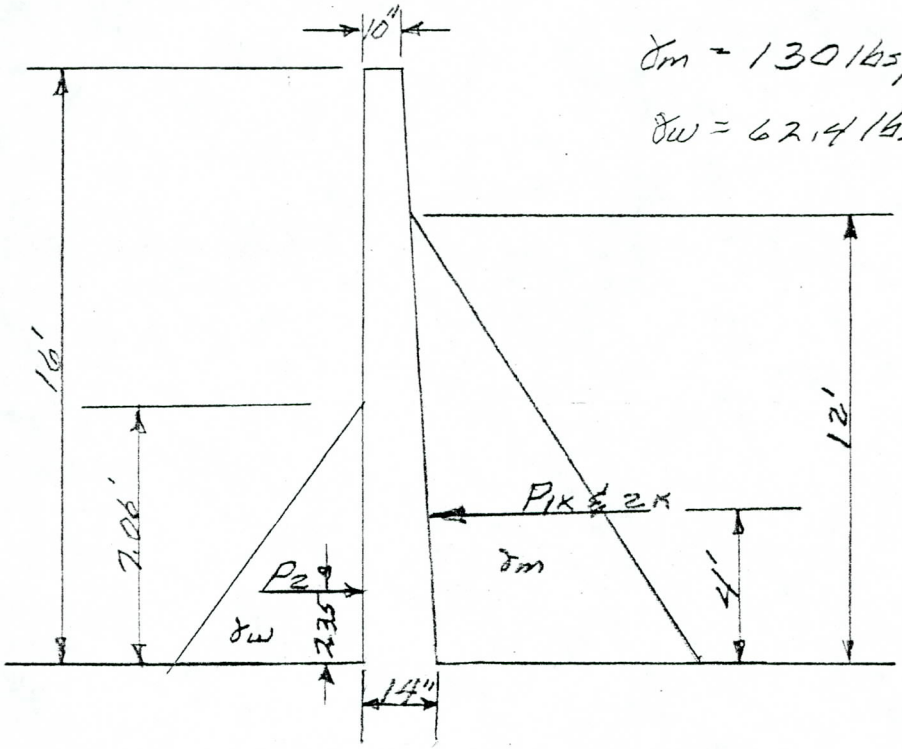
|---|---|---|---|---|
| Arizona | | Harquahala Valley WP | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. |
| W.E. Payne | 11-13-79 | [illegible] | 12-17-79 | ERS |
| SUBJECT | | | | SHEET 59 OF 65 |
| Emergency Spillway Design | | | | |

Loading of wall to do instead of HT.




$\gamma_m$ = 130 lbs/ft.

$\gamma_w$ = 62.4 lbs/ft.

$P_{1K} = \frac{K w h^2}{2} = 0.7 \times 130 \times \frac{12^2}{2} = 6552$ lbs. ←

$P_2 = \frac{w h^2}{2} = 62.4 \times \frac{7.06^2}{2} = 1555$ lbs. →

$P_{2K} = \frac{K w h^2}{2} = 0.35 \times 130 \times \frac{12^2}{2} = 3276$ lbs. ←

$M_{uex} = 6552 \times 4 - 1555 \times 2.35 = 22.5$ ft-K

$A_s = \frac{M}{f_s j d} = \frac{22.5 \times 12000}{20000 \times 0.87 \times 11.5} = 1.35 in^2$ #11 @ 12 ($A_s$ = 1.56)

$M_{ex} = 3276 \times 4 - 1555 \times 2.35 = 9.5$ ft-K

$A_s = \frac{9.5 \times 12000}{20000 \times 0.87 \times 11.5} = 0.57 in^2$ 7 @ 12 ($A_s$ = 0.6)

< 30' length

Temp. Steel = $0.002 \times 12 \times 14 = 0.34 in^2$

> 30' length #6 @ 12"

$0.003 \times 12 \times 14 = 0.50 in^2$ #7 @ 12

COMPUTATION SHEET

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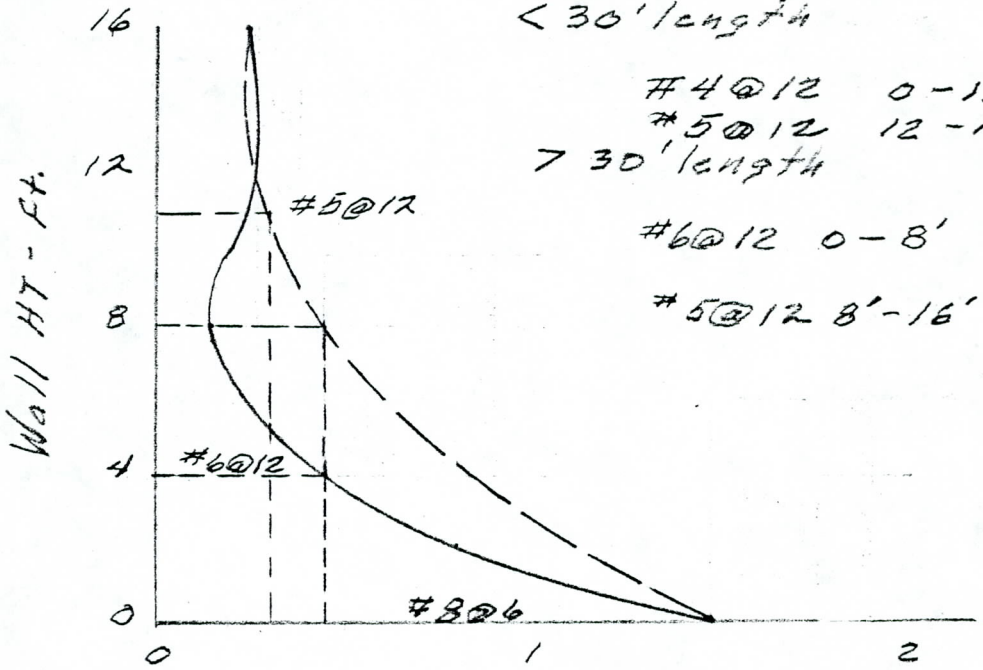
SOIL CONSERVATION SERVICE



| STATE | | PROJECT | | |
|---|---|---|---|---|
| Arizona | | Harquahala Valley WP | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. |
| W.E. Payne | 11-13-79 | [illegible] | 12-17-79 | FRS |

SUBJECT Emergency Spillway Design — SHEET 60 OF 65

## Wall Steel - Unexposed - HB = 12'




Horiz. Temp. steel

< 30' length

#4@12 0-12'

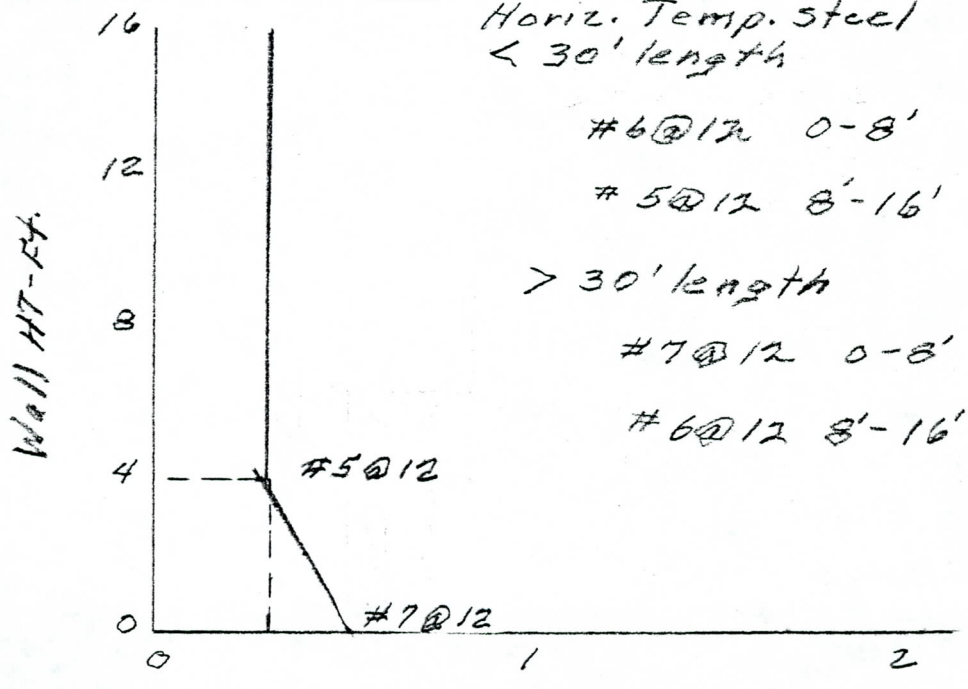
#5@12 12-16'

> 30' length

#6@12 0-8'

#5@12 8'-16'

## Wall Steel - Exposed




Horiz. Temp. steel

< 30' length

#6@12 0-8'

#5@12 8'-16'

> 30' length

#7@12 0-8'

#6@12 8'-16'

COMPUTATION SHEET

SCS-ENG-523 Rev. 8-69

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE



| STATE | | PROJECT | | |
|---|---|---|---|---|
| Arizona | | Harquahala Valley W.P. | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. |
| W.E. Payne | 11-14-79 | Sml | 12-17-79 | F.K.S |

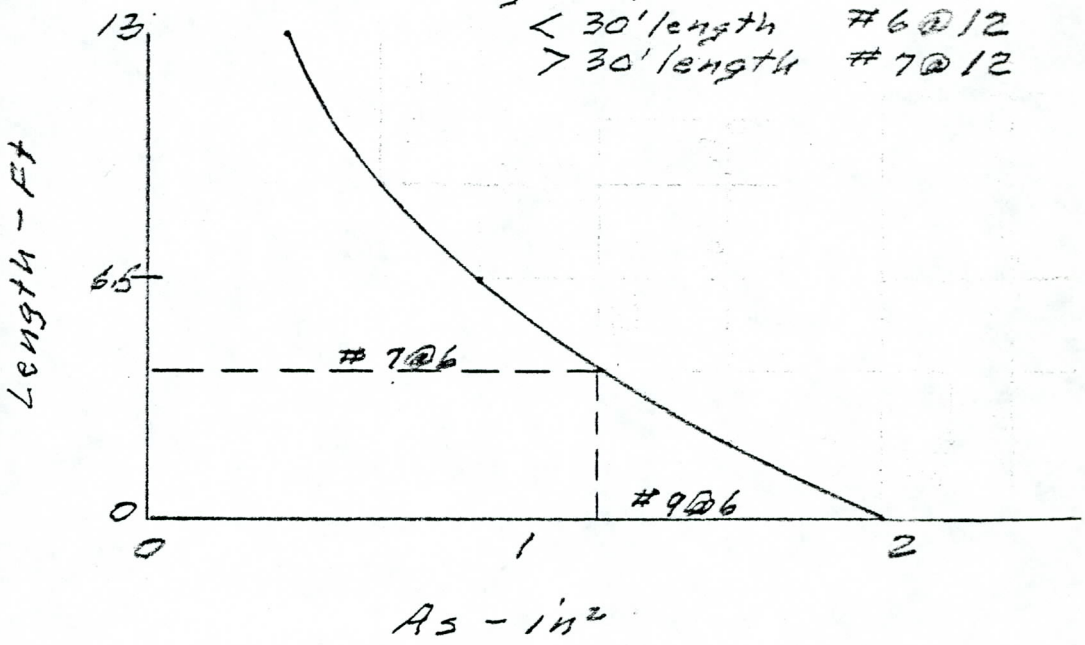
SUBJECT Emergency Spillway Design — SHEET 61 OF 65

Footing - Unexposed - HB = 12'

< 30' length #4@12, > 30' length #6@12

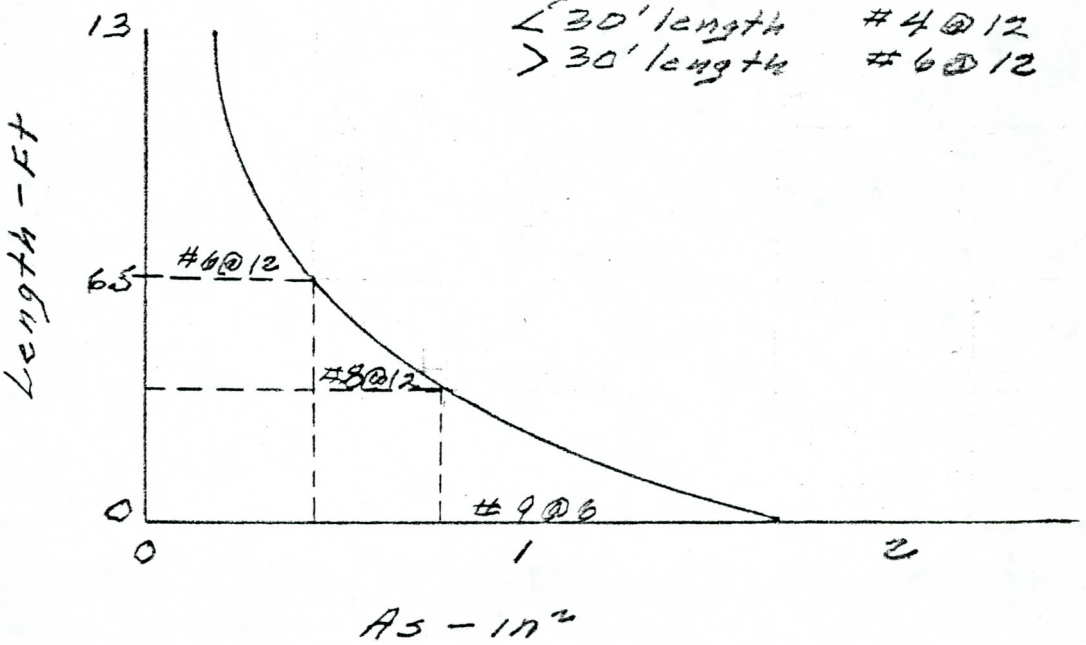
Toe - Exposed

Longit. Steel
< 30' length #6@12
> 30' length #7@12




Toe - Unexposed

Longit. Steel
< 30' length #4@12
> 30' length #6@12



COMPUTATION SHEET

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| BY | DATE | CHECKED BY | DATE | JOB NO. |
| W.F. Payne | 11-14-79 | SW | 12-17-79 | ERS |
| SUBJECT | | | | SHEET 62 OF 65 |
| Emergency Spillway Design | | | | |

Pavement Steel - Exposed - HB = 12'

Temp. Steel each way

< 30' length #5@12, > 30' length #6@12

Pavement Steel - Unexposed

Temp. Steel each way

< 30' length #4@12, > 30' length #5@12

COMPUTATION SHEET

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U. S. DEPARTMENT OF AGRICULTURE

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1960-335

| STATE | PROJECT | | |
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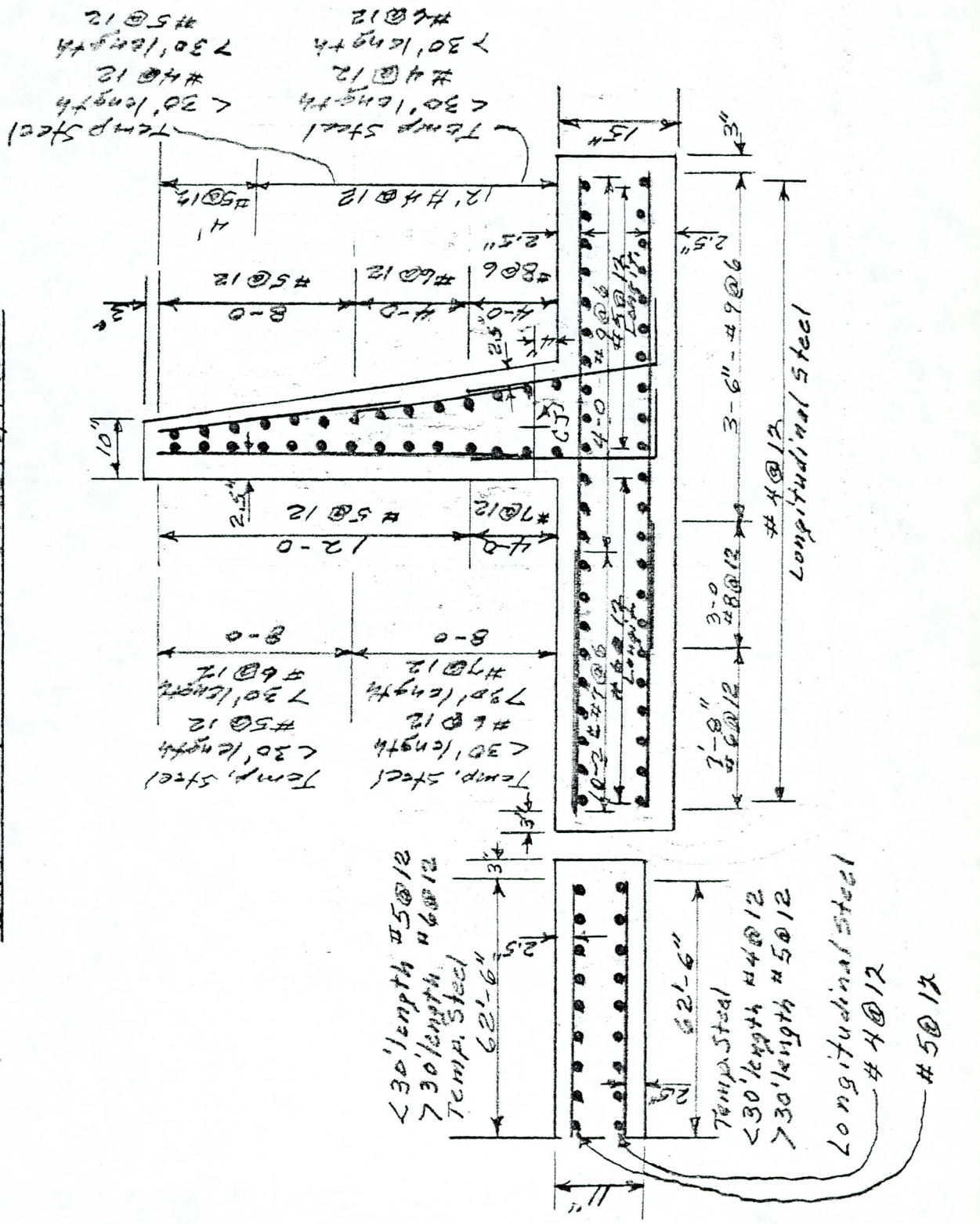
| Arizona | Harquahala Valley W.P. | | |
| BY / DATE | CHECKED BY / DATE | JOB NO. | |
| W.E. Payne / 12-13-78 | | FAS | |
| SUBJECT | | SHEET | |
| Emergency Spillway Design | | 63 OF 65 | |



COMPUTATION SHEET

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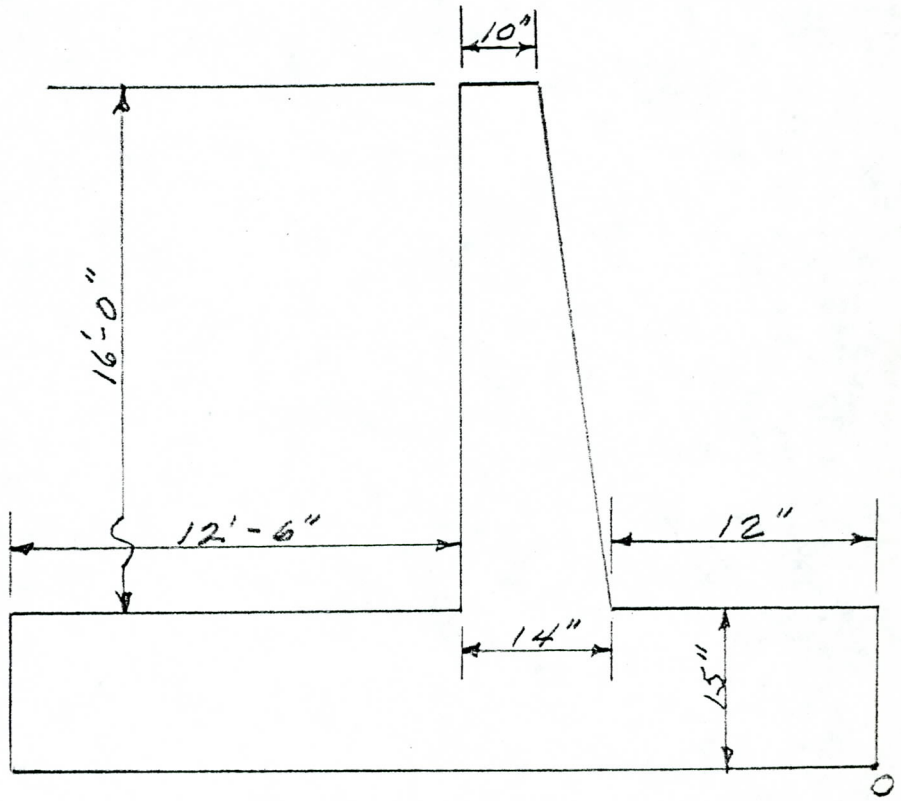
SOIL CONSERVATION SERVICE



| STATE Arizona | | PROJECT Harquahala Valley WP | | |
|---|---|---|---|---|
| BY W.E. Payne | DATE 3-4-80 | CHECKED BY | DATE | JOB NO. FRS |
| SUBJECT Emergency Spillway Design | | | | SHEET 64 OF 65 |

From the final computer design the X dimension was given as 13 ft. This was reduced to 12.5 ft. to facilitate the placement of the longitudinal joints between the blocks.

Now the wall and footing must be checked for overturning




Horizontal backfill at $h = 12'$

$$P = K_w \frac{h^2}{2} = 0.7 \frac{(130)(12)^2}{2} = 6552 \text{ lbs}$$

Take moments about "O".

Due to the compacted densities of the expected backfill materials (SM, GM, GP) rotation or differential settlement of the structure is not deemed to be a problem.

COMPUTATION SHEET

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| STATE | PROJECT | | |
|---|---|---|---|
| Arizona | Harquahala Valley WP | | |
| BY / DATE: W.E. Payne 3-4-80 | CHECKED BY / DATE | | JOB NO. FRS |
| SUBJECT: Emergency Spillway Design | | | SHEET 65 OF 65 |

| Part | Weight | Force | Arm | Moment |
|---|---|---|---|---|
| Footing<br>1.25 x 14.667 x 150 | 2750.06 | | 7.334 | 20168.94 |
| Wall<br>0.833 x 16 x 150 | 1999.2 | | 1.75 | 3498.60 |
| 0.333 x 16 x 0.5 x 150 | 399.6 | | 1.111 | 443.96 |
| Earth<br>1.0 x 12 x 130 | 1560.0 | | 0.5 | 780.0 |
| 0.083 x 12 x 0.5 x 130 | 64.74 | | 1.028 | 66.55 |
| $P = KWh^2/2$<br>$0.7 \times 130 \times 12^2 \times 0.5$ | | 6552 | 4.0 | 26208.0 |
| | 6773.6 | | | 51166.05 |

$z = \frac{51166.05}{6773.6} = 7.55 < 14.667 \times \frac{2}{3} = 9.78$ Stable

resultant falls with middle third.

Check for sliding

$P = K \gamma_m h = 0.7 \times 130 \times 13.25 = 1205.75$ lb/ft²

Driving force = $0.5 \times 1205.75 \times 13.25 = 7988.09$ lbs.

Total weight (from above) = 6773.6 lbs.

tan $\phi_f$ for silty, sandy gravels = 0.5

resistance = $6773.6 \times 0.5 = 3386.8$ lbs.

Factor of Safty against sliding

$FS = \frac{3386.8}{1205.75} = 2.8 > 1.5$ Okay wont slide

COMPUTATION SHEET
SCS-ENG-523 Rev. 8-69

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

| STATE | Arizona | PROJECT | Forquhahala Valley WP |
|---|---|---|---|
| BY | W.E. Payne | DATE | 3-18-80 |
| | | CHECKED BY | [illegible] |
| | | DATE | 5-13-80 |
| | | JOB NO. | FRS |
| SUBJECT | Emergency Spillway Design | SHEET | 1 OF |

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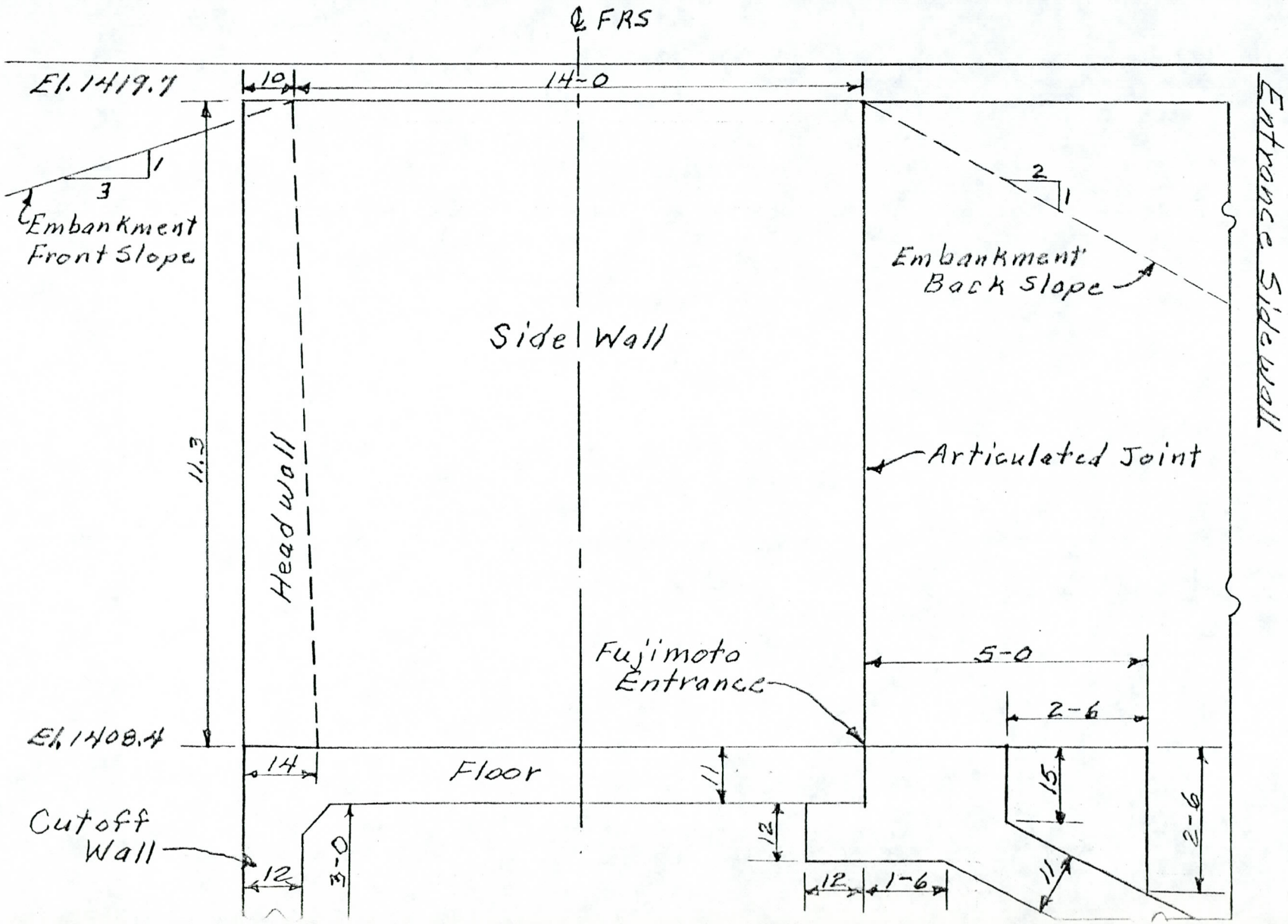
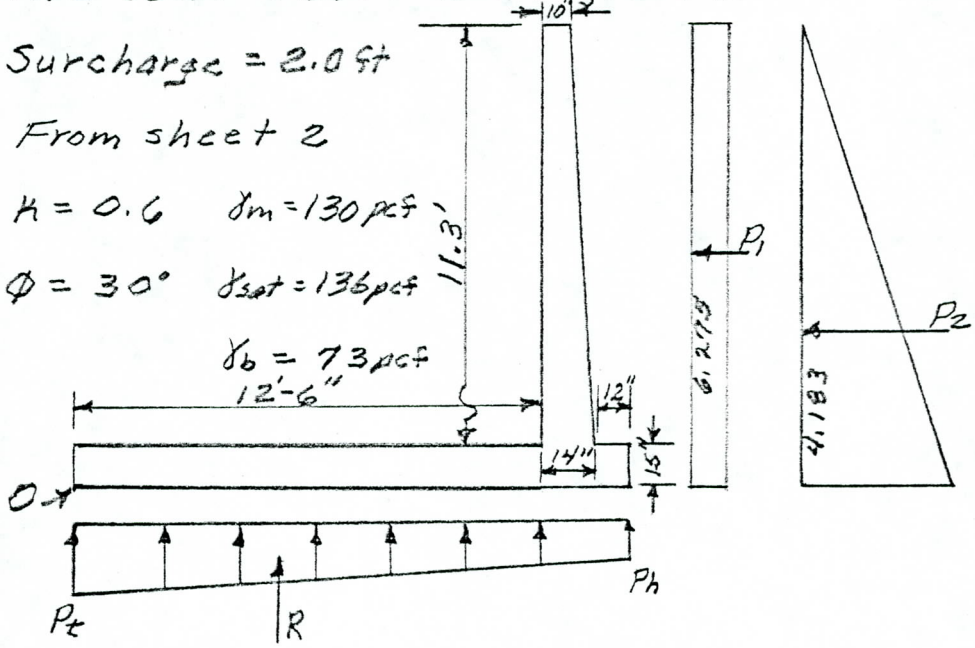
# Profile of Baffled Chute Entrance



| STATE | | PROJECT | | |
|---|---|---|---|---|
| Arizona | | Harquahala Valley WP | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. |
| BJV-WEP | 3-5-80 | [illegible] | 4-80 | FRS |
| SUBJECT | | | SHEET | OF |
| Emergency Spillway Design | | | 2 | |

The entrance to the emergency spillway will be articulated with the baffled chute. The computer design gives smaller dimensions than the chute due to smaller loadings. Since the entrance is small compared with the chute, the chute dimensions shall be used to eliminate forming problems by dimension changes and to facilitate the continuation of joints.




Surcharge = 2.0 ft

From sheet 2

$K = 0.6$ $\gamma_m = 130$ pcf

$\phi = 30°$ $\gamma_{sat} = 136$ pcf

$\gamma_b = 73$ pcf

$P_1 = K \gamma_m H = 0.6 \times 130 \times 2.0 = 156$ lb/ft

$P_2 = K \gamma_m \frac{H^2}{2} = 0.6 \times 130 \times \frac{12.55^2}{2} = 6142.6$ lb/ft

$W_s = 1.0 \times 11.3 \times 130 + 0.333 \times 11.3 \times 130 \times 0.5 = 1713.59$ lb.

$W_c = 0.833 \times 11.3 \times 150 + 0.333 \times 11.3 \times 150 \times 0.5 + 1.25 \times 14.667$

$\times 150 = 4444.22$ lbs.

Check for overturning

$\Sigma F_v = 0$

$W_s + W_c = P_h(\ell) + \frac{1}{2}(P_t - P_h)(\ell)$

$1713.59 + 4444.22 = P_h(14.667) + (P_t - P_h)\frac{(14.667)}{2}$

STATE Arizona | PROJECT Harquahala Valley WP.

BY RJW-WEP | DATE 3-5-80 | CHECKED BY [illegible] | DATE 4-80 | JOB NO. ERS

SUBJECT Emergency Spillway Design | SHEET 3 OF

$$6157.81 = 7.334(P_t + P_h)$$

$$P_t + P_h = 839.625$$

$$\Sigma M_o = 0$$

$$P_h(L)\left(\frac{l}{2}\right) + \tfrac{1}{2}(P_t - P_h)(L)\left(\frac{l}{3}\right) + 156(6.273) +$$

$$6142.6(4.183) - 0.833(11.3)(150)(12.917) -$$

$$0.333(11.3)(150)(0.5)(13.444) - 1.25(14.667)(150)(73$$

$$-1.0(11.3)(130)(14.167) - 0.333(11.3)(130)(0.5)(13.889) =$$

$$107.56P_h + 35.853(P_t - P_h) + 978.588 + 25694.496$$

$$-18237.964 - 3794.132 - 20168.958 - 20811.32$$

$$-3397.09 = 0$$

$$107.56P_h + 35.853(P_t - P_h) = 39736.383$$

$$107.56P_h + 35.853P_t - 35.853P_h = 39736.383$$

$$71.707P_h + 35.853P_t = 39736.383$$

$$P_t = 1108.314 - 2P_h$$

$$1108.314 - 2P_h + P_h = 839.625$$

$$P_h = 268.689$$

$$P_t = 1108.314 - 537.378 = 570.936$$

$$0 = P_h\left(\frac{l^2}{2}\right) + (P_t - P_h)\left(\frac{l^2}{4}\right) - W(x)$$

$$6157.81X = 268.689(107.561) + 302.247(35.853$$

$$6157.81X = 28900.458 + 10836.462 = 39736.919$$

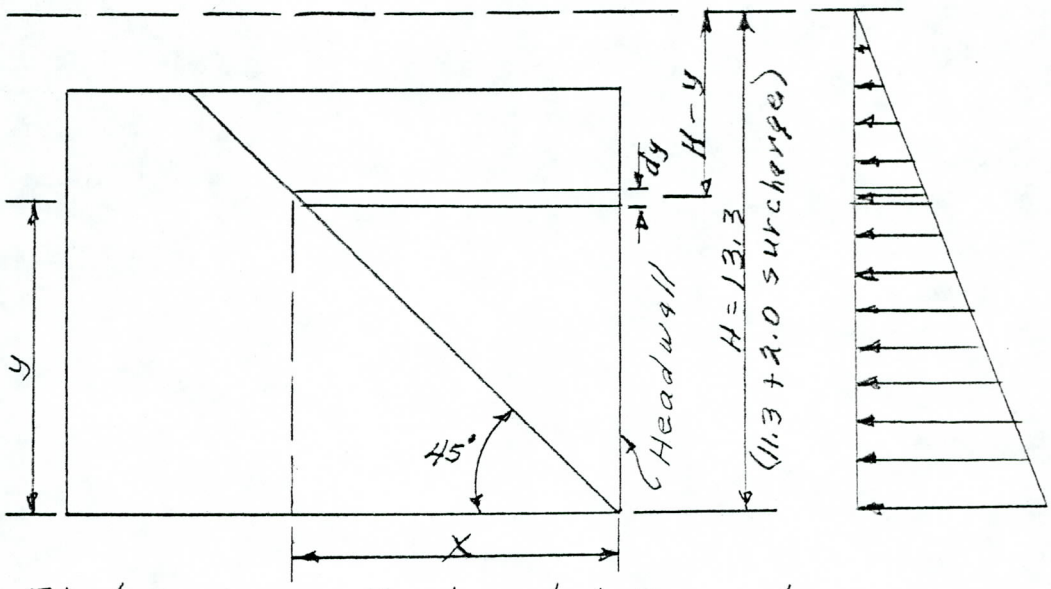
$$X = 6.453 < 9.783 \quad \text{Stable}$$

inside the middle third

| STATE | PROJECT | | | |
|---|---|---|---|---|
| Arizona | Horsehale Valley W.P. | | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. |
| PJW-WEP | 3-20-80 | SWL | 5-13-80 | FRS |
| SUBJECT | | | | SHEET 4 OF |
| Emergency Spillway Design | | | | |

## Entrance Side Wall

Compute maximum moments using 45° line and cantilever theory.




Find Maximum Horizontal Moment

$$dM = K\gamma_m (H-y)(x)\left(\frac{x}{2}\right)dy = K\gamma_m (H-y)\left(\frac{y^2}{2}\right)dy$$

K = 0.6 Effective Fluid Pressure
$\gamma_m$ = 130 lb/ft³

x = y

Substitute for x

$$dM = K\gamma_m (H-y)\left(\frac{y^2}{2}\right)dy = K\gamma_m \left(\frac{Hy^2}{2} - \frac{y^3}{2}\right)dy$$

Maximum Moment occurs when $\frac{dM}{dy} = 0 = Hy - \frac{3}{2}y^2$

$y = 0$ and $y = \frac{2}{3}H$

$$M_{max} = K\gamma_m \left(H - \tfrac{2}{3}H\right)\left(\frac{\frac{2}{3}H}{2}\right)^2 = 0.6(130)\left[13.3 - \left(\tfrac{2}{3}\right)(13.3)\right]\left(\frac{\frac{2}{3}(13.3)}{2}\right)$$

$M_{max}$ = 13593 ft-lb.

ES-164, $f'_c$ = 4000 psi Min d = 7.1 in. Computer design of side wall for chute required 10" top, 14" base. The entrance section will match this. ∴ Min. t @ 8.87 = 7.1 + 3.5 = 10.6"
Slope = 4"(11.3-8.87)/11.3 = 0.86" + 10 = 10.86" > 10.6" O.K.

| STATE | | PROJECT | | |
|---|---|---|---|---|
| Arizona | | Harquahala Valley WP | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. |
| RJW-WEP | 3-20-80 | [illegible] | 5-13-70 | FRS |
| SUBJECT | | | | SHEET 5 OF |
| Emergency Spillway Design | | | | |

Maximum Shear

$dV = K\gamma_m (H-y)(x)\,dy \qquad x = y$

Substitute for x $dV = K\gamma_m (H-y)(y)\,dy = K\gamma_m (Hy - y^2)\,dy$

Maximum shear occurs when $\frac{dV}{dy} = 0 = K\gamma_m (H-2y)$

$y = \frac{H}{2}$

$V_{max} = K\gamma_m \left(\frac{H^2}{2} - \frac{H^2}{4}\right) = 0.6(130)\left(\frac{13.3^2}{4}\right) = 3449.4 \text{ lbs.}$

Horizontal Steel (Unexposed face) $d = 12.666 - 2.5 = 10.166$

$A_s = \frac{12M}{f_s j d} = \frac{12(13593)}{20000(7/8)(10.17)} = 0.92 \text{ in}^2$

$\Sigma o = \frac{8V}{7du} = \frac{8(3449)}{7(10.17)(350)} = 1.11 \text{ in}$

| | | | |
|---|---|---|---|
| #9 @ 12 | $A_s = 1.00 \text{ in}^2$ | $\Sigma o = 3.54 \text{ in}$ | ← Use |
| #8 @ 9 | $A_s = 1.05 \text{ in}^2$ | $\Sigma o = 4.19 \text{ in}$ | |
| #7 @ 6 | $A_s = 1.20 \text{ in}^2$ | $\Sigma o = 5.50 \text{ in}$ | |

Vertical Steel (Unexposed face)

From ES-4, $M = \frac{K\gamma_m (y-h)^2 (y+2h)}{6}$

$M = \frac{0.6(130)(13.3-2)^2[13.3+(2)(2)]}{6} = 28717 \text{ ft-lbs.}$

$A_s = \frac{12M}{f_s j d} = \frac{12(28717)}{20000(7/8)(11.5)} = 1.71 \text{ in}^2$

$V = \frac{K\gamma_m (y^2 - h^2)}{2} = \frac{0.6(130)(13.3^2 - 2^2)}{2} = 6742.7 \text{ lbs.}$

$\Sigma o = \frac{8V}{7du} = \frac{8(6743)}{7(11.5)(350)} = 1.91 \text{ in.}$

| | | | |
|---|---|---|---|
| #11 @ 9 | $A_s = 2.08 \text{ in}^2$ | $\Sigma o = 5.91 \text{ in}$ | |
| #9 @ 6 | $A_s = 2.001 \text{ in}^2$ | $\Sigma o = 7.091 \text{ in}$ | ← Use |

Find where #7 @ 6 ($A_s = 1.20 \text{ in}^2$) can be used

Allowable M = 16,900 ft-lbs (From ES-164)

| STATE | PROJECT | | | |
|---|---|---|---|---|
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| BY / DATE | CHECKED BY / DATE | | JOB NO. | |
| RJW-WEP 3-20-80 | SMW 5-13-80 | | FRS | |
| SUBJECT | | | SHEET 6 OF | |
| Emergency Spillway Design | | | | |

$\frac{16900}{0.6(130)}$ = 216.7 (From ES-4) 13.3 - 11.0 = 2.3' above floor.

Find where #5@6 ($A_s$ = 0.61 in²) can be used.

Allowable M = 6800 ft-lbs. (From ES-164)

$\frac{6800}{0.6(130)}$ = 87.2 (From ES-4) 13.3 - 8.5 = 4.8' above floor

Check design using TR-50 Computer Program for No Flow and Full Flow conditions without surcharge load. Use $k_{01}$ = 0.70 same as used for chute design.

See sheets 8 and 9 for computer results.

See sheets 10, 11 and 12 for dimensions and steel layout.

Temperature Steel Exposed Face

$A_s = 0.002(12)(14) = 0.34 in^2$ #6@12

$A_s = 0.002(12)(12) = 0.29 in^2$ #5@12

$A_s = 0.002(12)(10) = 0.24 in^2$ #5@12

Determine As-Height curve to locate point steel can be reduced in size.

$M = \frac{K\gamma_m}{6}(y-h)^2(y+2h)$

y varies from 0 to 13.3 ft. h = 2 ft.

$6M = K\gamma_m(y^2-2yh+h^2)(y+2h)$

$6M = K\gamma_m(y^2-4y+4)(y+4)$

$6M = K\gamma_m(y^3-12y+16)$

$6M = 0.6(130)(y^3-12y+16) = 78y^3-936y+1248$

$M = 13y^3-156y+208$

COMPUTATION SHEET

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SOIL CONSERVATION SERVICE

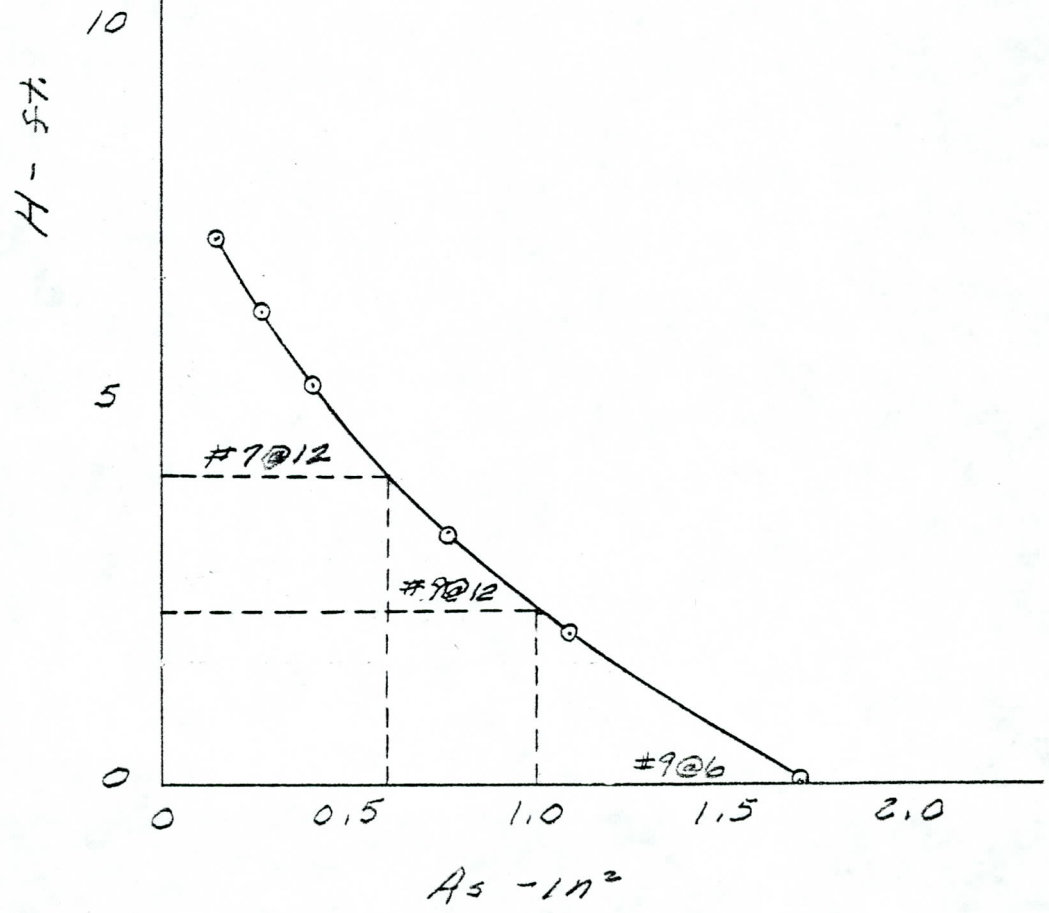


| STATE | PROJECT | | | |
|---|---|---|---|---|
| Arizona | Harquahala Valley W.P. | | | |
| BY | DATE | CHECKED BY | DATE | JOB NO |
| RJW-WEA | 3-26-80 | [illegible] | 5-13-80 | FRS |

SUBJECT Emergency Spillway Design — SHEET 7 OF

| H | y | $y^3$ | M | d | As |
|---|---|---|---|---|---|
| 0 | 13.3 | 2352.64 | 28717 | 11.5 | 1.71 |
| 2 | 11.3 | 1442.90 | 17203 | 10.79 | 1.09 |
| 3.3 | 10 | 1000 | 11648 | 10.33 | 0.77 |
| 5.3 | 8 | 512 | 5616 | 9.63 | 0.40 |
| 6.3 | 7 | 343 | 3575 | 9.27 | 0.26 |
| 7.3 | 6 | 216 | 2080 | 8.92 | 0.16 |
| 8.3 | 5 | 125 | | | |
| 9.3 | 4 | 64 | | | |

To prevent the sidewall from sliding, the sidewall footing will be tied into the baffle chute footing.



COMPUTATION SHEET

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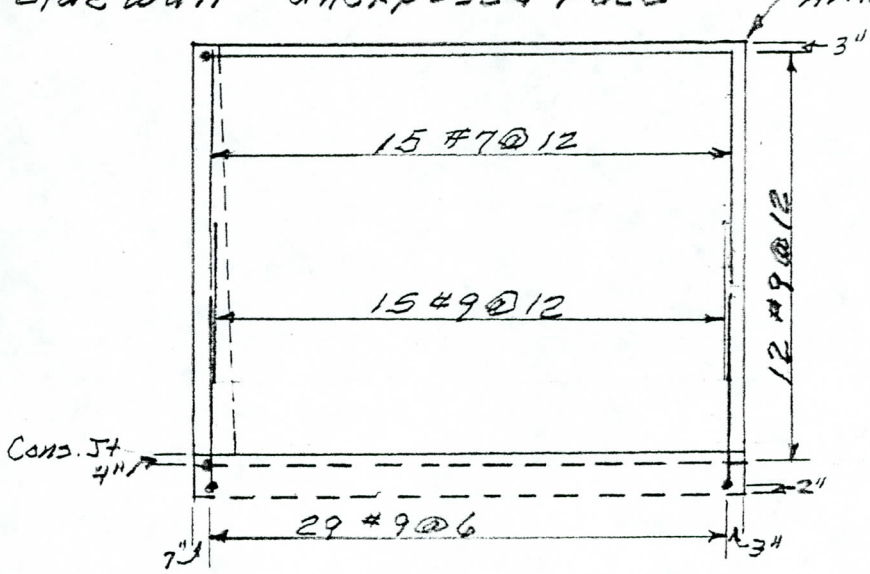
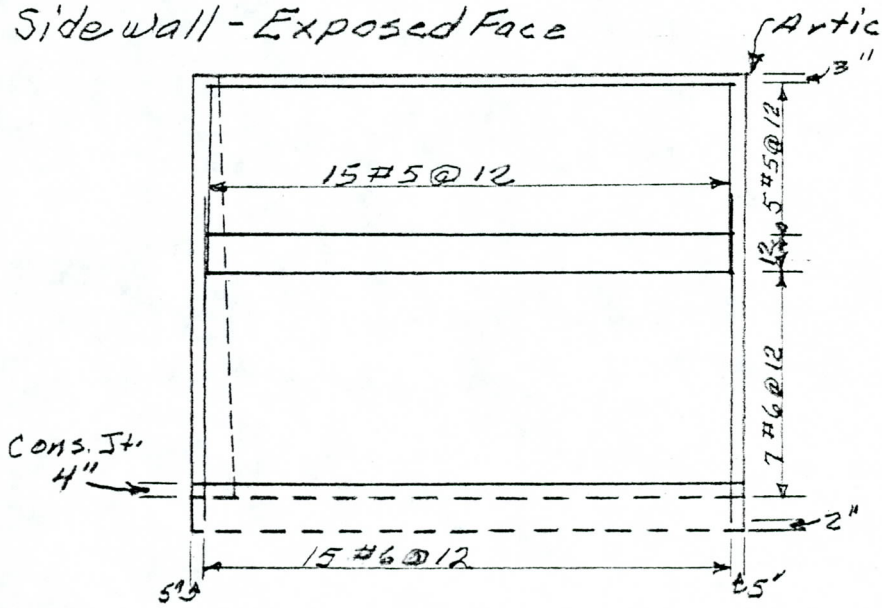
| STATE | PROJECT | | | |
|---|---|---|---|---|
| Arizona | Harquahala Valley WP | | | |
| BY | DATE | CHECKED BY | DATE | JOB NO |
| RJW-WEP | 3-20-80 | Shw | 5-13-80 | ERS |
| SUBJECT | | | | SHEET 10 OF |
| Emergency Spillway Design | | | | |

Side wall - Unexposed Face




| | | | | |
|---|---|---|---|---|
| H #9@12 | length | 14-0 + 2-0 | = 16-0 | ⌐ |
| V #9@6 | length | 6-3 | = 6-3 | ⌐ |
| V #9@12 | length | 6-3 | = 6-3 | — |
| V #7@12 | length | 7-1 + 2-3 | = 9-4 | — |

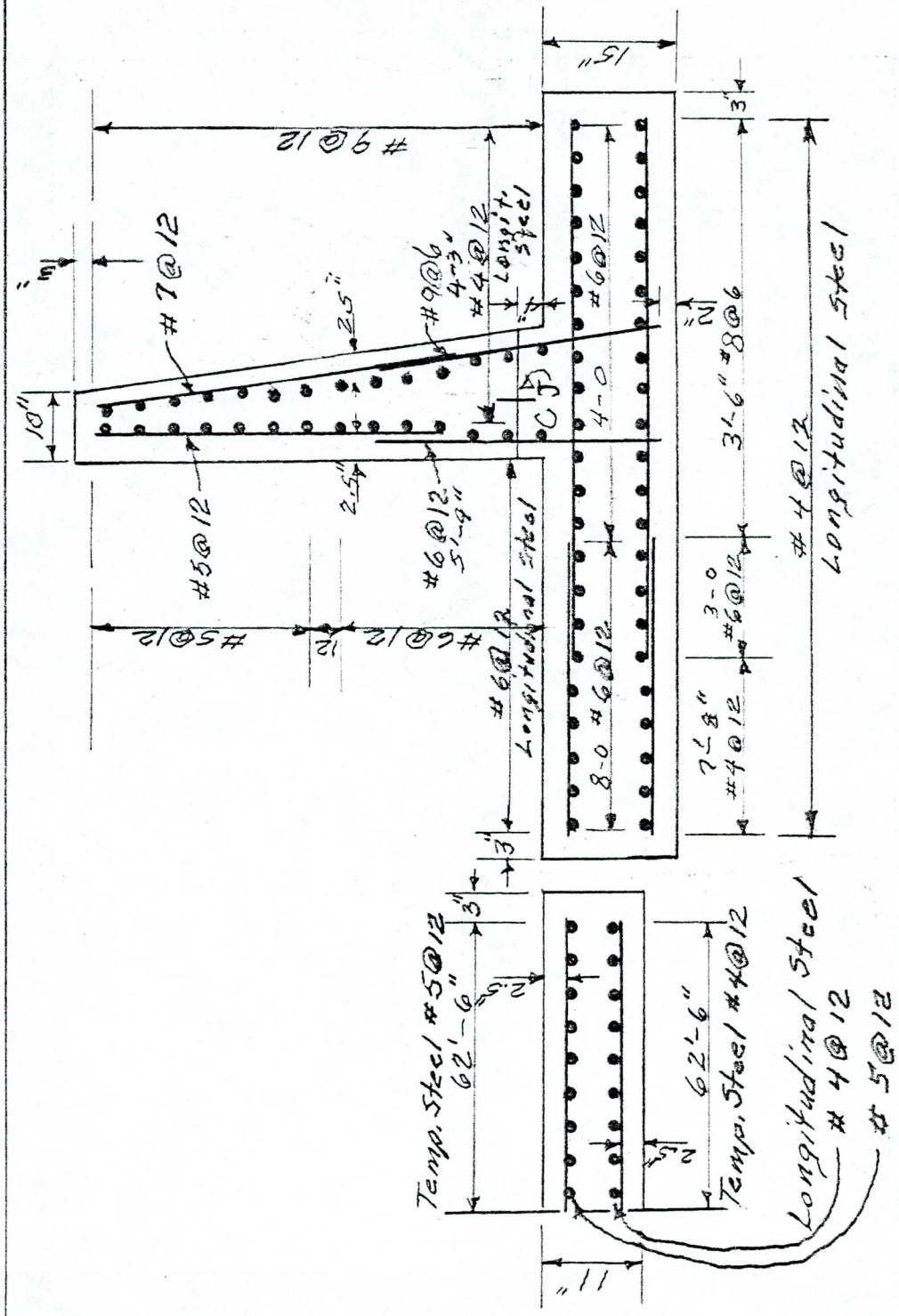
Side wall - Exposed Face




| | | | | |
|---|---|---|---|---|
| H #6@12 | length | | = 14-0 | — |
| H #5@12 | length | | = 14-0 | — |
| V #6@12 | length | 6-9 | = 6-9 | — |
| V #5@12 | length | 5-9 + 1-9 | = 7-6 | — |

| STATE | | PROJECT | | |
|---|---|---|---|---|
| Arizona | | Harquahala Valley W.P. | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. |
| W.E. Payne | 3-18-80 | SJW | 5-13-80 | FRS |
| SUBJECT | | | SHEET | OF |
| Emergency Spillway Design | | | 11 | |

## Chute Entrance Steel - Side Wall & Floor



COMPUTATION SHEET
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| STATE | | PROJECT | | |
|---|---|---|---|---|
| Arizona | | Harquahala Valley WA | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. |
| W.E. Payne | 4-17-80 | [illegible] | 5-13-80 | ERS |
| SUBJECT | | | | SHEET 14 OF |
| Emergency Spillway Design | | | | |

Determine depth of cutoff and toe wall.

The cutoff wall is to reduce uplift pressures, prevent piping and resist sliding. The uplift pressures were considered in the T.A. 50 loading and computer design. Sliding was considered in the chute design and since the chute is below the entrance and the entrance is contained and restricted by the chute, the entrance is not expected to slide. Therefore a 3 foot cutoff wall with a drain will be used to control the possibility of piping.

The toe wall is to prevent piping and undermining of the floor. A one foot toe wall will be keyed into the rock foundation since piping and undermining will not be a problem at this location.

Due to the coarse material (GM, GP) assumed as embankment in this location cracking is not expected to be a problem but the drain shall be designed to accept the flow from a crack.

From Buckeye Site 1 Drain Report, March 25, 1980 the maximum size crack found was 0.5 inches in width at a depth of 3 feet below the ground surface. Therefore, assume piping will begin at the chute entrance with a crack extending from the surface to a depth of 4 feet. The crack opening, at that depth, would be approximately 0.05 ft. by 0.05 ft. The crack will be considered as a short tube under the cut off wall.

$A = 0.05 \times 0.05 = 0.0025 \text{ ft}^2$

$h = 11.3 + 0.917 + 3.0 + \frac{0.05}{2} = 15.242 \text{ ft.}$

$C = 0.75$ (From King's)

$Q = CA\sqrt{2gh} = 0.75(0.0025)(31.33) = 0.057 \text{ cfs.}$

COMPUTATION SHEET
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| STATE | | PROJECT | | |
|---|---|---|---|---|
| Arizona | | Harquahala Valley WP | | |
| BY | DATE | CHECKED BY | DATE | JOB NO |
| W.E. Payne | 4-17-80 | [illegible] | 5-13-80 | FRS |
| SUBJECT | | | | SHEET 15 OF |
| Emergency Spillway Design | | | | |

Determine if 6 inch diameter, perforated pipe has sufficient capacity to carry crack discharge.

$A = 0.1963\ ft.^2$

$h = 11.3 + 0.917 + 1.5 = 13.717\ ft.$

$C = C_{10} - 0.02D = 0.34 - 0.02(0.5) = 0.33$

$Q = CA\sqrt{2gh} = 0.33(0.1963)(29.722) = 1.925\ cfs.$

$1.925 > 0.059$ O.K.

A 6 inch diameter pipe will carry the discharge from approximately 32.6 cracks of the above size. The sand-gravel filter will be designed to prevent the embankment material from reaching the pipe. The pipe will be perforated.

Temp. & Shrinkage steel Will be sufficient

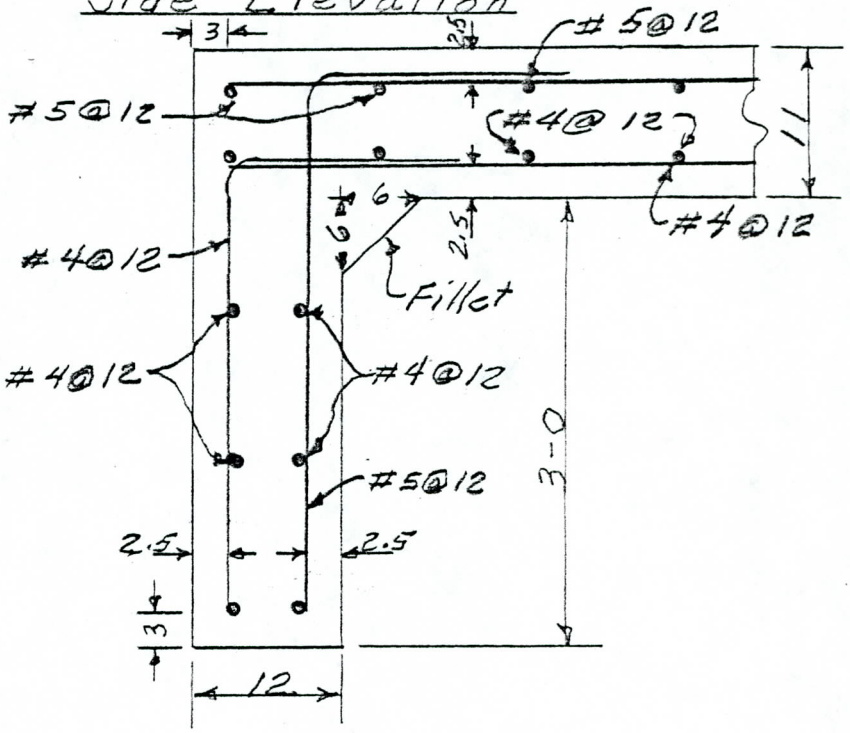
$A_s = 0.001(12)(12) = 0.14\ in^2$ Use #4 @ 12

$A_s = 0.20\ in^2$

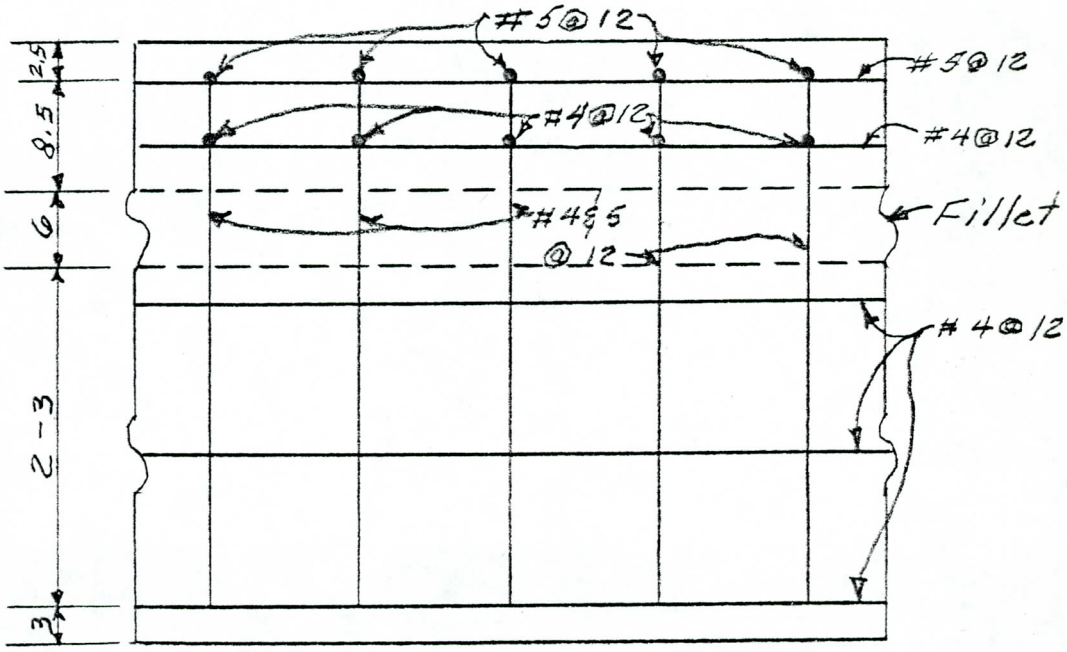
| STATE | | PROJECT | | |
|---|---|---|---|---|
| Arizona | | Harquahala Valley W.P. | | |
| BY | DATE | CHECKED BY | DATE | JOB NO |
| W.E. Payne | 3-19-80 | DW | 4-80 | FRS |
| SUBJECT | | | | SHEET 16 OF |
| Emergency Spillway Design | | | | |

## Chute Entrance Floor Cutoff

### Side Elevation




### Front Elevation



COMPUTATION SHEET

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|---|---|---|---|---|
| Arizona | | Harquahala Valley WP | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. |
| W.E. Payne | 4-21-80 | [illegible] | 5-15-80 | FRS |
| SUBJECT | | | | SHEET 17 OF |
| Emergency Spillway Design | | | | |

Rock Riprap at the side of Baffled Chute

The junction of the earth embankment and the concrete chute sides produces an area of erosion from normal rainfall runoff and possible splash from the chute when it is in operation.

The design of the riprap is adapted from TSC Advisory ENG-PO-18 and Highway Research Board Report 108, Page 37.

Assume: $z = 0.1$ $b = 10$ ft.

$d = 0.1$ ft. $Se = 0.5$

Specific Gravity = 2.65

$Qd = 0.5$ cfs (Splash)

$A = d(b + zd) = 0.1[10 + (0.1)(0.1)] = 1.0 \text{ ft}^2$

$P = b + (\sqrt{z^2+1})(2d) = 10 + (\sqrt{0.1^2+1})(2)(0.1) = 10.2$ ft.

$R = \frac{A}{P} = \frac{1.0}{10.2} = 0.098$

$d'_{50} = \left[\frac{118 Qd Se^{13/6} R}{P}\right]^{0.40} = \left[\frac{118(0.5)(0.5)^{13/6}(0.098)}{10.2}\right]^{0.4} = (0.126)^{0.4} =$

0.437 ft. Use 5 in.

$d_{50} = K_{SG} K_A K_S d'_{50}$

Since S.G. = 2.65 then $K_{SG} = 1.0$

| STATE | | PROJECT | | |
|---|---|---|---|---|
| Arizona | | Harquahala Valley WP | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. |
| W.E. Payne | 4-21-80 | | 5-15-80 | FRS |
| SUBJECT | | | | SHEET 18 OF |
| Emergency Spillway Design | | | | |

$B_s$ = 10 ft. $R_o$ = straight alignment

therefore $\frac{B_s}{R_o} = 0$

$\frac{T}{T_o} = 1.5$ $K_A = \frac{1.5}{1.5} = 1.0$

$\theta$ = angle of repose for rock $\approx 40°$

$\phi$ = slope angle = 26°34' (z = 2:1)

$K_{ACTUAL} = K_2 = \sqrt{1 - \frac{\sin^2\phi}{\sin^2\theta}} = \sqrt{1 - \left(\frac{0.4472}{0.6428}\right)^2} = 0.718$

$K_{recom}$ (for z = 2:1) = 0.718

$K_s = \frac{K_{recom}}{K_{actual}} = \frac{0.718}{0.718} = 1.0$

$K = K_{SG} K_A K_s = (1.0)(1.0)(1.0) = 1.0$

$d_{50} = K d'_{50} = (1.0)(5) = \underline{5 \text{ inches}}$

The safty factor of 1.25 is sufficient for this location and situation.

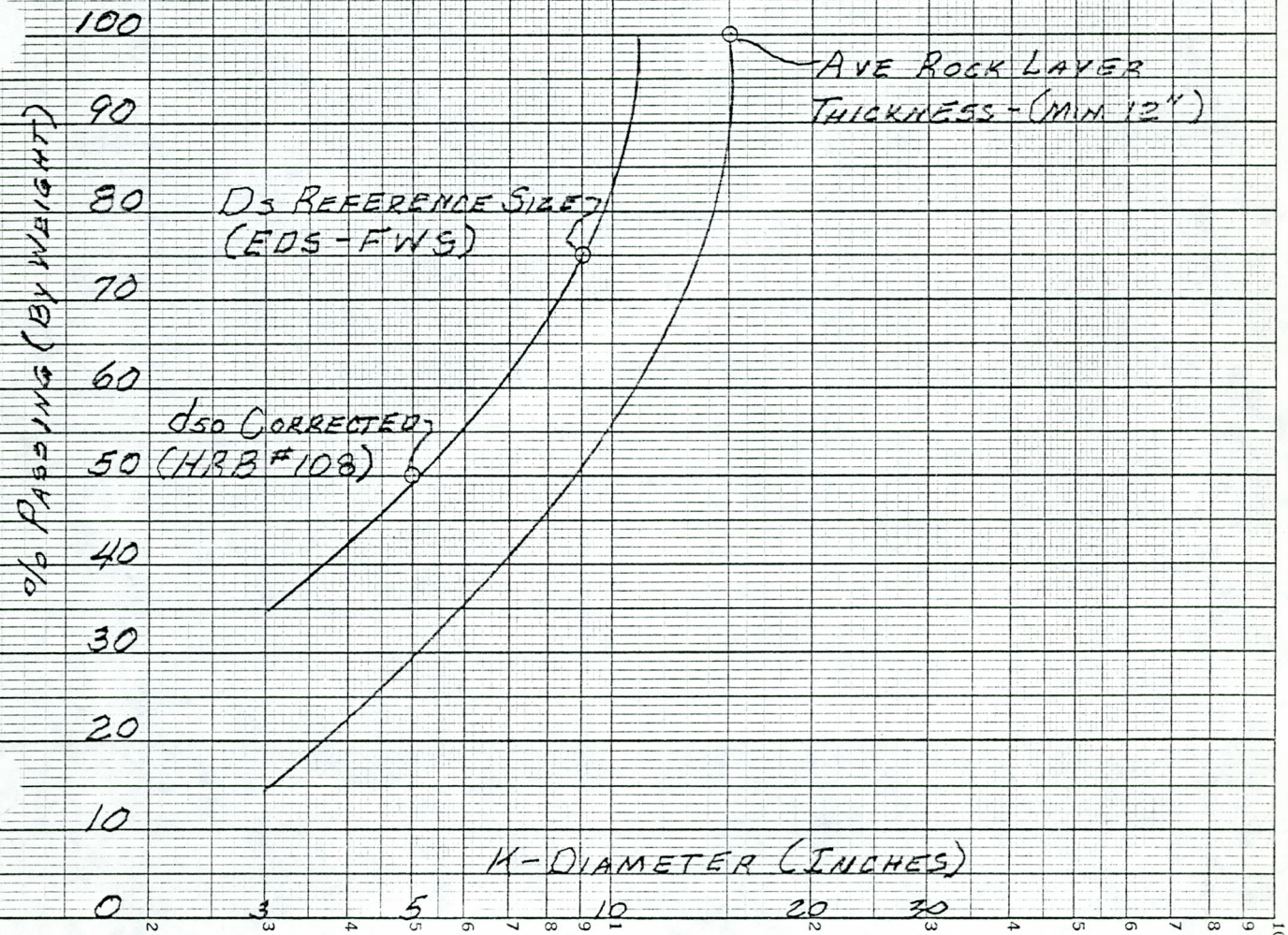
| % finer than | Diameter inches |
|---|---|
| 100 | 15 |
| 65-100 | 12 |
| 51-75 | 9 |
| 35-55 | 6 |
| 15-35 | 3 |

Riprap thickness = $3 d_{50} = 3(5) = \underline{15 \text{ inches}}$

Bedding (filter) = <u>6 inches</u>

Arizona — Harquahala Valley Irr. Dist.
W.E. Payne 4-21-80 — ERS
Emergency Spillway Design — Sheet 19 of

# Rock Riprap Gradation Envelope



SCS-ENG-353 (REV. 3-70)
FILE CODE ENG-22

MATERIALS TESTING REPORT | U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE | SOIL CLASSIFICATION

PROJECT and STATE: Parqua Hala Valley Arizona
FIELD SAMPLE NO.: TP-24
DEPTH: 0-3.9'
GEOLOGIC ORIGIN: Upper Alluvial Fan
SAMPLE LOCATION: Cmp 88+00
TYPE OF SAMPLE: Disturbed
TESTED AT: SHEB
APPROVED BY:
DATE:
LABORATORY NO.: 54-6335
SYMBOL: GM
DESCRIPTION: Sandy Silty Gravel

## GRAIN SIZE DISTRIBUTION

| $D_{10}$ | $D_{15}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{85}$ | $D_{MAX}$ | $C_u$ | $C_c$ |
|---|---|---|---|---|---|---|---|---|
| | | | 1.5 | 4.0 | 17 | 76.1 | | |

FINES | SANDS | GRAVELS | COBBLES

SIEVE OPENING, (mm)
Page 37 HRB #108

U.S. STANDARD SIEVE SIZE: #200 #140 #100 #60 #50 #40 #30 #20 #16 #10 #8 #4 3/8" 1/2" 3/4" 1" 1 1/2" 2" 3" 6" 12"

PERCENT FINER BY DRY WEIGHT

GRAIN SIZE IN MILLIMETERS: 0.001 0.002 0.003 0.004 0.005 0.01 0.02 0.03 0.04 0.05 0.1 0.2 0.3 0.4 0.5 1.0 2.0 3.0 4.0 5.0 10 20 30 40 50 100 200 300 400 500 1000 2000 3000 4000

$d_{15}$ Riprap = 40 / 11 = 2.4 < 5
$d_{85}$ Base
$d_{15}$ Riprap = 40 / 0 = ∞ > 40
$d_{15}$ Base

A Filter Required

Filter Design
$d_{50}$ Filter < 40 x 1.5 = 60
$d_{15}$ Filter < 40 x 0 = 0
$d_{85}$ Filter < 5 x 17 = 85
$d_{15}$ Filter > 5 x 0 = 0

Filter Required
$d_{50}$ Filter > 170/40 = 4.25
$d_{15}$ Filter > 40/40 = 1
$d_{85}$ Filter > 40/5 = 8
$d_{15}$ Filter < 40/5 = 8

Base
Filter Required
Riprap
Filter
Design

| SPECIFIC GRAVITY ($G_s$) | | ATTERBERG LIMITS | | | | | | SOLUBLE SALTS | SHRINKAGE LIMIT | UNDISTURBED CONDITION | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | NATURAL MOISTURE | | AIR DRY | | OVEN DRY | | | | MOISTURE | DRY UNIT WEIGHT |
| (-) #4 | (+) #4 | LL | PI | LL | PI | LL 33 | PI 8 | % | % | 2.8 % | g/cc / pcf |

REMARKS:

Sheet 20 of

SCS-ENG-353 (REV. 3-70)
FILE CODE ENG-22

Sheet 21 of 25

# MATERIALS TESTING REPORT — U.S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE — SOIL CLASSIFICATION

LABORATORY NO. 65-335

PROJECT and STATE: Parowan Valley Project, Utah
SAMPLE LOCATION: Cap
FIELD SAMPLE NO.: TP-96
DEPTH: 6'-9'
GEOLOGIC ORIGIN: Upper Alluvial Fan
TYPE OF SAMPLE: Disturbed
TESTED AT: SMSB
APPROVED BY:
DATE:

SYMBOL GM
DESCRIPTION Silty Sandy Gravel

## GRAIN SIZE DISTRIBUTION

| $D_{10}$ | $D_{15}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{85}$ | $D_{MAX}$ | $C_u$ | $C_c$ |
|---|---|---|---|---|---|---|---|---|
| | | 1.5 | 6.35 | 10.0 | 55 | 101.6 | | |

FINES | SANDS | GRAVELS | COBBLES

SIEVE OPENING (mm) (.074) (.105) (.149) (.250) (.297) (.420) (.595) (.841) (1.19) (2.00) (2.36) (4.76) (9.50) (12.7) (19.0) (25.4) (38.1) (50.8) (76.1) (152) (304+)

U.S. STANDARD SIEVE SIZE #200 #140 #100 #60 #50 #40 #30 #20 #16 #10 #8 #4 3/8" 1/2" 3/4" 1" 1 1/2" 2" 3" 6" 12"

PERCENT FINER BY DRY WEIGHT

GRAIN SIZE IN MILLIMETERS

Page 37 HRB #108

$d_{15}$ Riprap $= \frac{50}{55} = 0.9 < 5$ A Filter Required

$d_{85}$ Base

$d_{15}$ Riprap $= \frac{50}{0} = 87.40$

$d_{15}$ Base

Filter Design

$d_{50}$ Filter $< 40 \times 6.35 = 254$

$d_{15}$ Filter $< 40 \times 0 = 0$

$d_{15}$ Filter $< 5 \times 55 = 275$

$d_{15}$ Filter $> 5 \times 0 = 0$

Filter Required

$d_{50}$ Filter $> \frac{254}{40} = 4.5$

$d_{15}$ Filter $> \frac{50}{40} = 1.25$

$d_{85}$ Filter $> \frac{50}{5} = 10$

$d_{15}$ Filter $< \frac{50}{5} = 10$

Filter Required

Base

Riprap

Filter Designed

| SPECIFIC GRAVITY ($G_s$) | | ATTERBERG LIMITS | | | | | | SOLUBLE SALTS | SHRINKAGE LIMIT | UNDISTURBED CONDITION | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | NATURAL MOISTURE | | AIR DRY | | OVEN DRY | | | | MOISTURE | DRY UNIT WEIGHT |
| (-) #4 | (+) #4 | LL | PI | LL | PI | LL 31 | PI 5 | % | % | 2.0 % | g/cc / pcf |

REMARKS:

Sheet 22 of

SCS-ENG-353 (REV. 3-70)
FILE CODE ENG-22

LABORATORY NO 166 of 335

| MATERIALS TESTING REPORT | U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE | SOIL CLASSIFICATION |
|---|---|---|

PROJECT and STATE: HARQUAHALA VALLEY ARIZONA
SAMPLE LOCATION CAP 882+00
FIELD SAMPLE NO.: TP-86
DEPTH: 12'-15'
GEOLOGIC ORIGIN: Upper Alluvial Fan
TYPE OF SAMPLE: Disturbed
TESTED AT: SHEB
APPROVED BY:
DATE:
SYMBOL: GM
DESCRIPTION: Silty Sandy Gravel

GRAIN SIZE DISTRIBUTION

| $D_{90}$ | $D_{15}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{85}$ | $D_{MAX}$ | $C_u$ | $C_c$ |
|---|---|---|---|---|---|---|---|---|
| | | 0.36 | 2.8 | 4.9 | 14.5 | 50.8 | | |

COBBLES | GRAVELS | SANDS | FINES

SIEVE OPENING (mm)

U.S. STANDARD SIEVE SIZE

Page 37 HB3 #108

$d_{15}$ Riprap = 50 = 3.4 < 5
$d_{85}$ Base 14.5
$d_{15}$ Riprap = 50 = 8 > 40
$d_{15}$ Base 0
Filter Design
$d_{50}$ Filter < 40 x 2.8 = 112
distFilter < 40 x 0 = 0
distFilter < 5 x 14.5 = 72.5
$d_{15}$ Filter > 5 x 0 = 0
Filter Required
$d_{50}$ Filter > 120 = 1.25
distFilter > 40 = 1.25
$d_{50}$ Filter > 50 = 10
distFilter > 5 = 10
$d_{85}$ Filter < 50 = 10
distFilter < 5 = 10

Base
A Filter Required
Filter Required
Riprap

GRAIN SIZE IN MILLIMETERS

PERCENT FINER BY DRY WEIGHT

| SPECIFIC GRAVITY ($G_s$) | | ATTERBERG LIMITS | | | | | | | | SOLUBLE SALTS % | SHRINKAGE LIMIT % | UNDISTURBED CONDITION | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | NATURAL MOISTURE | | AIR DRY | | OVEN DRY | | | | | | MOISTURE % | DRY UNIT WEIGHT g/cc pcf |
| (-) #4 | (+) #4 | LL | PI | LL | PI | LL | PI | | | | | 5.3 % | 97.4 pcf |

REMARKS:

Sheet 23 of

SCS-ENG-353 (REV. 3-70)
FILE CODE ENG-22

LABORATORY NO 167 of 335

# MATERIALS TESTING REPORT | U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE | SOIL CLASSIFICATION

PROJECT and STATE: HARQUAHALA VALLEY ARIZONA

SAMPLE LOCATION: C.A.P. 1013+00

FIELD SAMPLE NO.: DH-59

DEPTH: 8'-33'

GEOLOGIC ORIGIN: Upper Alluvial Fan

TYPE OF SAMPLE: Disturbed

TESTED AT: SH&B

APPROVED BY:

DATE:

SYMBOL: GM

DESCRIPTION: Silty Sandy Gravel

GRAIN SIZE DISTRIBUTION

$D_{90}$ | $D_{15}$: 0.105 | $D_{30}$: 1.3 | $D_{50}$: 4.5 | $D_{60}$: 6.5 | $D_{85}$: 13 | $D_{MAX}$: 38.1 | $C_u$ | $C_c$

FINES | SANDS | GRAVELS | COBBLES

U.S. STANDARD SIEVE SIZE

SIEVE OPENING (mm)

Pape 32 HR 8703

PERCENT FINER BY DRY WEIGHT

GRAIN SIZE IN MILLIMETERS

Filter Design
$d_{50}$ Filter $\leq 40 \times 4.5 = 180$
$d_{15}$ Filter $\leq 40 \times 0.105 = 4.2$
$d_{85}$ Filter $\leq 5 \times 13 = 65$
$d_{15}$ Filter $\geq 5 \times 0.105 = 0.5$

Filter Required

$d_{15}$ Filter $= 59 = 3.8 < 4.5$ Filter Required
$d_{85}$ Filter $= 13$
Use Filter $= 5D = 5 \times 40$
$d_{15}$ Base $= 0.105$

Filter Required
$d_{50}$ Filter $> \frac{60}{40} = 1.5$
$d_{15}$ Filter $< \frac{60}{40} = 0.5$
$d_{85}$ Filter $> \frac{100}{5} = 20$
$d_{15}$ Filter $< \frac{100}{5} = 20$

Base
Filter Designed
Riprap

UNDISTURBED CONDITION: MOISTURE %; DRY UNIT WEIGHT g/cc, pcf

SHRINKAGE LIMIT %

SOLUBLE SALTS %

ATTERBERG LIMITS: NATURAL MOISTURE LL PI; AIR DRY LL PI; OVEN DRY LL PI: NP

SPECIFIC GRAVITY ($G_s$): (+) #4; (-) #4

REMARKS:

| STATE | | PROJECT | | |
|---|---|---|---|---|
| Arizona | | Harquahala Valley W.P. | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. |
| W. E. Payne | 4-21-80 | | | FRS |
| SUBJECT | | | | SHEET 24 OF |
| Emergency Spillway Design | | | | |

## Rock Riprap For Entrance To Chute

The entrance to the chute is on a reverse grade therefore will be affected by erosion only from normal rainfall and receding emergency spillway flow.

The design of the riprap is adapted from the Engineering Design Standards For West States - Pages 16-13a, b, c & d.

Z = 2:1 then K = 0.72

Straight channel inlet then C = 1.0

Assume D = 1.0 ft. Maximum

$$Ds = \frac{3.5 w DS}{CK} = \frac{3.5(62.4)(1.0)(0.01)}{1.0(0.72)} = 3.03 \text{ in.}$$

Use the same riprap gradation and filter as will be used on the chute sides.

Riprap thickness = 15 in.

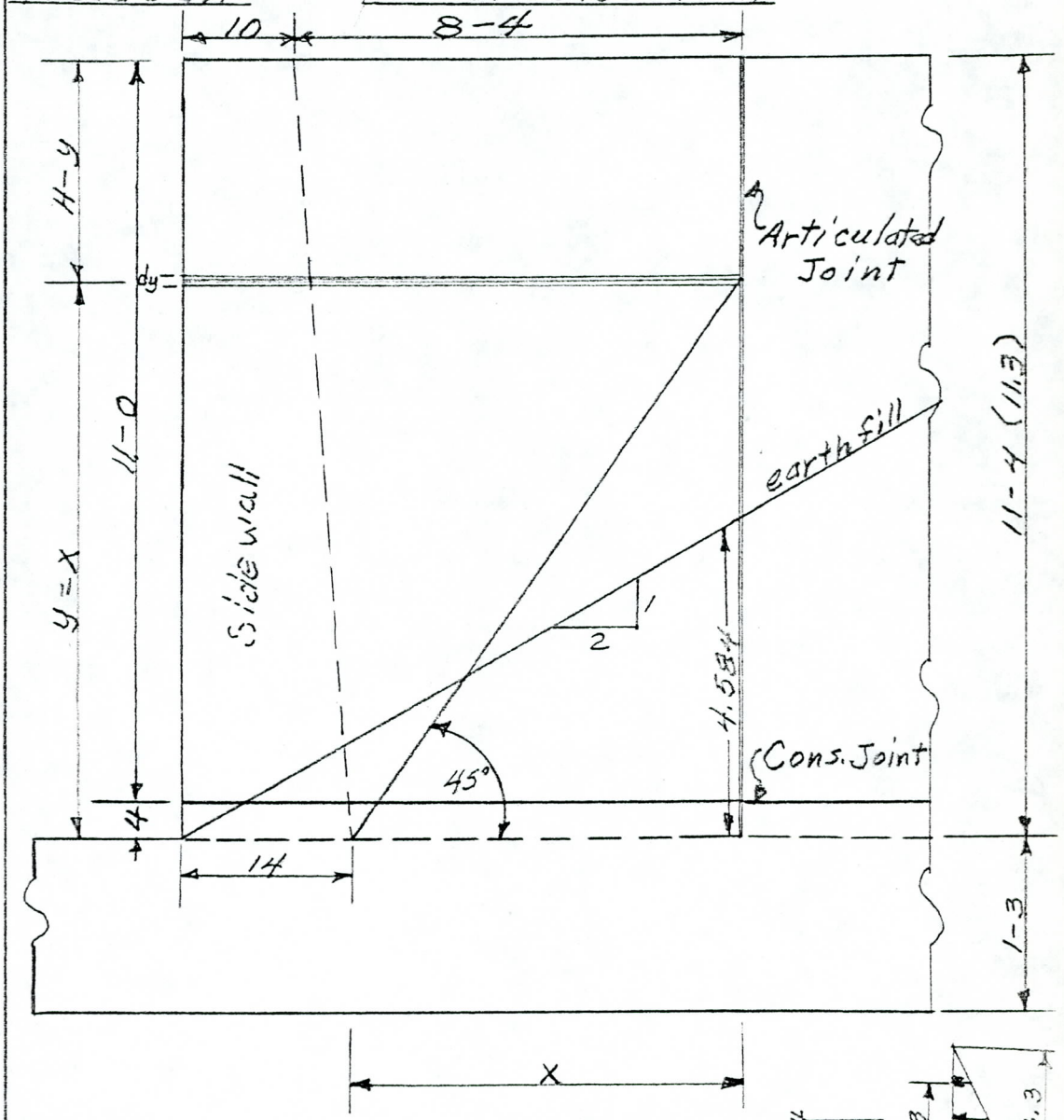
Bedding (filter) = 6 in.

Total = 21 in.

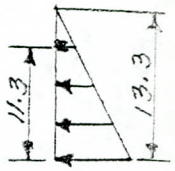
From HRB #108 Figure 21 V = 8.7 fps max from W.S. profiles $d_{50}$ = 50 m.m. = 2 in. Use the same riprap & filter as used on chute sides.

| STATE | | PROJECT | | |
|---|---|---|---|---|
| Arizona | | Harquahala Valley WP | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. |
| W.E. Payne | 3-24-80 | [illegible] | 6-80 | FRS |
| SUBJECT | | | | SHEET 2.5 OF |
| Emergency Spillway Design | | | | |

Headwall Front Elevation




L = 8' $t_T$ = 10" $t_B$ = 14" Loading =




Battered to match sidewall

From sidewall computation the moment is maximum when $y = \frac{2}{3}H$, $V_{max} = y = \frac{H}{2}$

Horizontal Moment $dM = K\delta m(H-y)(\frac{X^2}{2})dy$

$M = 0.6(130)[13.3 - \frac{2}{3}(13.3)]\frac{(\frac{2}{3}13.3)^2}{2} = 13593.0$ ft-lb.

Try when x = 8' and y = 8'

| STATE | PROJECT | | | |
|---|---|---|---|---|
| Arizona | Harquahala Valley W.P. | | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. |
| W.E. Payne | 3-24-80 | [illegible] | 6-80 | EAS |
| SUBJECT | | | | SHEET 26 OF |
| Emergency Spillway Design | | | | |

$M = 0.6(130)(13.3-8)\frac{(8)^2}{2} = 13228.8$ ft-lbs.

$dV = k\gamma_m(H-y)(x)\,dy \qquad x = y$

$V = 0.6(130)(13.3-\frac{8}{2})(\frac{8}{2}) = 2901.6$ lbs.

Horizontal Steel - Unexposed face

$A_s = \frac{12M}{f_s j d} = \frac{12(13228.8)}{20000(7/8)(8.663)} = 1.051 in^2$

$z_o = \frac{V}{jdu} = \frac{8(2901.6)}{7(8.663)(350)} = 1.09$ in.

| | | |
|---|---|---|
| #10@12 | $A_s = 1.27 in^2$ | $z_o = 3.99$ in. |
| #9@12 | $A_s = 1.00 in^2$ | $z_o = 3.54$ in. |
| #8@9 | $A_s = 1.05 in^2$ | $z_o = 4.19$ in. |
| #7@6 | $A_s = 1.20 in^2$ | $z_o = 5.50$ in. |

Find where #8@12 is sufficient. $M = k\gamma_m(H-x)\frac{l^2}{2}$

$10200 = 0.6(130)(5.3)\frac{l^2}{2}$ $\quad l^2 = 49.35 \quad l = 7.025$

$8 - 7.025 = 0.975'$ Use 1.0' from inside face

Vertical Steel - Unexposed face

$M = \frac{k\gamma_m}{6}(y_1-h_1)^2(y_1+2h_1) - \frac{k\gamma_m}{6}(y_2-h_2)^2(y_2+2h_2)$ [ES-4]

$V = \frac{k\gamma_m}{2}(y_1^2-h_1^2) - \frac{k\gamma_m}{2}(y_2^2-h_2^2)$

$M = \frac{0.6(130)}{6}(8.0-0)^2(8.0) - \frac{0.6(130)}{6}(4.584-0)^2(4.584) =$

$6656 - 1252.2 = 5403.8$ ft-lbs.

$V = \frac{0.6(130)}{2}(8.0)^2 - \frac{0.6(130)}{2}(4.584)^2 =$

$2496 - 819.5 = 1676.5$ lbs.

$A_s = \frac{12M}{f_s j d} = \frac{12(5403.8)}{20000(7/8)(11.5)} = 0.32 in^2$

$z_o = \frac{V}{jdu} = \frac{8(1676.5)}{7(11.5)(350)} = 0.48$ in.

| | | |
|---|---|---|
| #6@12 | $A_s = 0.44 in^2$ | $z_o = 2.36$ in. |
| #5@9 | $A_s = 0.41 in^2$ | $z_o = 2.62$ in. |
| #4@6 | $A_s = 0.39 in^2$ | $z_o = 3.14$ in. |

| STATE | PROJECT | | |
|---|---|---|---|
| Arizona | Harquahala Valley WP. | | |
| BY / DATE | CHECKED BY / DATE | | JOB NO. |
| RJW-WEP 3-25-80 | DWC 6-80 | | FRS |
| SUBJECT Emergency Spillway Design | | | SHEET 27 OF |

Headwall - Cont'd Consider the headwall to have a t = 10" with no batter. Same loading and moment as before. L = 8'

Horizontal Steel - Unexposed face

$$A_s = \frac{12M}{f_s j d} = \frac{12(13228.8)}{20000(7/8)(7.5)} = 1.21 \text{ in}^2$$

$$\Sigma o = \frac{V}{j d u} = \frac{8(3449.4)}{7(7.5)(350)} = 1.50 \text{ in.}$$

| | | |
|---|---|---|
| #10 @ 12 | $A_s = 1.27 \text{ in}^2$ | $\Sigma o = 3.99$ in. |
| #9 @ 9 | $A_s = 1.33 \text{ in}^2$ | $\Sigma o = 4.73$ in. |
| #7 @ 6 | $A_s = 1.20 \text{ in}^2$ | $\Sigma o = 5.50$ in. |

Vertical Steel - Unexposed face

$$A_s = \frac{12M}{f_s j d} = \frac{12(5407.8)}{20000(7/8)(7.5)} = 0.49$$

$$\Sigma o = \frac{V}{j d u} = \frac{8(1676.5)}{7(7.5)(350)} = 0.73 \text{ in.}$$

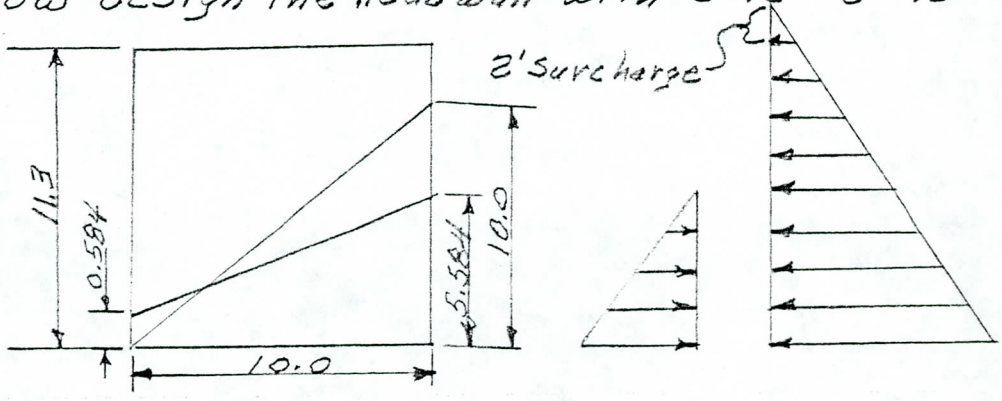
| | | |
|---|---|---|
| #7 @ 12 | $A_s = 0.60 \text{ in}^2$ | $\Sigma o = 2.75$ in. |
| #6 @ 9 | $A_s = 0.59 \text{ in}^2$ | $\Sigma o = 3.14$ in. |
| #5 @ 6 | $A_s = 0.61 \text{ in}^2$ | $\Sigma o = 3.93$ in. |

Exposed face - Temperature Steel

$$A_s = 0.002(12)(10) = 0.24 \text{ in}^2$$

#5 @ 12 ($A_s = 0.31 \text{ in}^2$ = $\Sigma o = 1.96$ in)

Now design the headwall with L = 10' t = 10"



| STATE | PROJECT | | |
|---|---|---|---|
| Arizona | Harquahala Valley WP | | |
| BY / DATE | CHECKED BY / DATE | | JOB NO. |
| RJW-WEP 3-26-80 | DWL 6-80 | | FRS |
| SUBJECT | | | SHEET 32 OF |
| Emergency Spillway Design | | | |

#10@12 $A_s = 1.27 in^2$ $\Sigma o = 3.99 in.$
#9@9 $A_s = 1.33 in^2$ $\Sigma o = 4.73 in.$
#8@6 $A_s = 1.57 in^2$ $\Sigma o = 6.28 in.$

Vertical Steel - Unexposed face

From ES-4 $M = \frac{KXm}{6}(y-h)^2(y+2h) =$

$\frac{0.6(130)}{6}(13.3-2)^2[13.3+2(2)] - \frac{0.6(130)}{6}(11.3-0)^2(11.3+0) =$

9959.8 ft-lb.

$V = \frac{KXm}{2}(y^2-h^2) = \frac{0.6(130)}{2}(13.3^2-2^2) - \frac{0.6(130)}{2}(11.3^2) =$

1762.8 lb.

$A_s = \frac{12M}{f_s j d} = \frac{12(9959.8)}{20000(7/8)(7.5)} = 0.91 in^2$

$\Sigma o = \frac{V}{j d u} = \frac{8(1762.8)}{7(7.5)(350)} = 0.77 in$

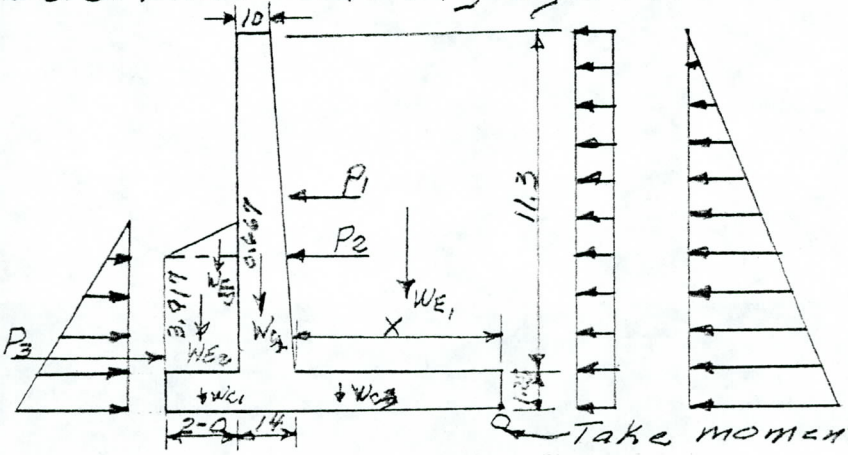
#9@12 $A_s = 1.00 in^2$ $\Sigma o = 3.54 in.$
#8@9 $A_s = 1.05 in^2$ $\Sigma o = 4.19 in.$
#7@6 $A_s = 1.20 in^2$ $\Sigma o = 5.50 in.$

Exposed face #5@12 Temp. Steel or #4@9

Use a headwall that is battered, L = 8 ft

$t_T = 10''$, $t_B = 14''$ H = 11.3 ft.

Determine Stability against overturning



STATE Arizona | PROJECT Hargwahala Valley WP

BY RJW-WEP | DATE 3-26-80 | CHECKED BY [illegible] | DATE 6-80 | JOB NO. FRS

SUBJECT Emergency Spillway Design | SHEET 33 OF

| Part | Weight | Force | Arm | Moment |
|---|---|---|---|---|
| $W_{C1}$ $2.0(150)(1.25)$ | 375.0 | | 10.167 | 3812.625 |
| $W_{C2}$ $1.0(150)(11.3)$ | 1695.0 | | 8.5 | 14407.5 |
| $W_{C3}$ $X=8$ $9.167(150)(1.25)$ | 1718.813 | | 4.584 | 7879.039 |
| $W_{E1}$ $X=8$ $8.167(130)(11.3)$ | 11997.323 | | 4.084 | 48997.067 |
| $W_{E2}$ $2.0(130)(3.917)$ | 1018.42 | | 10.167 | 10354.276 |
| $W_{E3}$ $2.0(130)(0.667)(0.5)$ | 86.71 | | 9.833 | 852.619 |
| $P_1$ $2.0(130)(0.6)(12.55)$ | | 1957.8 | 6.275 | 12285.195 |
| $P_2$ $130(0.6)(.05)(12.55)^2$ | | 6142.598 | 4.183 | 25694.457 |
| $P_3$ $-130(0.6)(5.834)^2(.05)$ | | -1327.387 | 1.945 | -2581.768 |
| | 16891.266 | | | 121701.04 |

$$Z = \frac{121701.04}{16891.266} = 7.205 < \tfrac{2}{3}(11.167) = 7.445 \quad \text{Stable}$$

Try shortening the back footing to $X = 7.0$ ft.

COMPUTATION SHEET

SCS-ENG-523 Rev. 8-69

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

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| STATE | PROJECT | | | |
|---|---|---|---|---|
| Arizona | Harquahala Valley WP | | | |
| BY | DATE | CHECKED BY | DATE | JOB NO |
| RJW-WEP | 3-26-80 | [illegible] | 6-80 | ERS |

SUBJECT Emergency Spillway Design — SHEET 34 OF

| Part | Weight | Force | Arm | Moment $M_o$ |
|---|---|---|---|---|
| $W_{C1}$ $2.0(150)(1.25)$ | 375.0 | | 9.167 | 3437.625 |
| $W_{C2}$ $1.0(150)(11.3)$ | 1695.0 | | 7.5 | 12712.5 |
| $W_{C3}$ $X=7$ $8.167(150)(1.25)$ | 1531.313 | | 4.084 | 6253.882 |
| $W_{E1}$ $X=7$ $7.167(130)(11.3)$ | 10528.323 | | 3.584 | 37733.51 |
| $W_{E2}$ $2.0(130)(3.917)$ | 1018.42 | | 9.167 | 9335.856 |
| $W_{E3}$ $2.0(130)(0.667)(0.5)$ | 86.71 | | 8.833 | 765.909 |
| $P_1$ $2.0(130)(0.6)(12.55)$ | | 1957.8 | 6.275 | 12285.195 |
| $P_2$ $130(0.6)(0.5)(12.55)^2$ | | 6142.598 | 4.183 | 25694.487 |
| $P_3$ $-130(0.6)(5.834)^2(0.5)$ | | -1327.387 | 1.945 | -2581.765 |
| | 15234.766 | | | 105637.196 |

$$Z = \frac{105637.196}{15234.766} = 6.933 < \tfrac{2}{3}(10.167) = 6.778$$

Unstable

Use the 8 ft. footing for the 8 ft. length of the headwall. The footing will be tied to the sidewall footing and the headwall extension footing.

COMPUTATION SHEET

SCS-ENG-523 Rev. 8-69

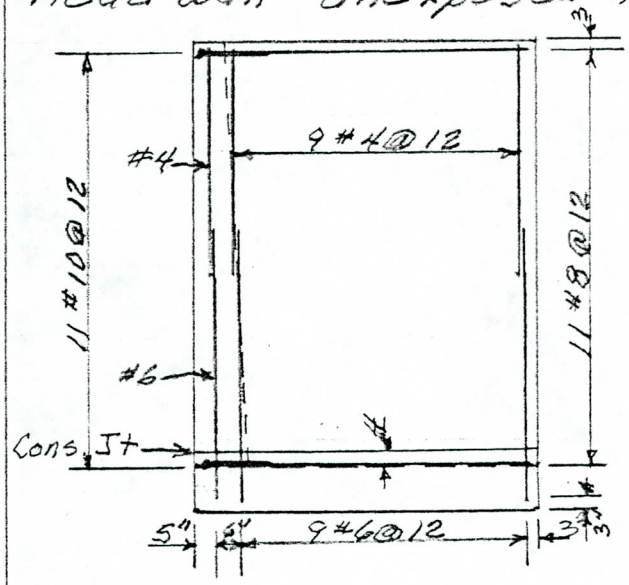
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE



| STATE | | PROJECT | | |
|---|---|---|---|---|
| Arizona | | Harquahala Valley WA | | |
| BY / DATE | CHECKED BY / DATE | | JOB NO. | |
| RJW-WEP 3-27-80 | SW 6-80 | | ERS | |

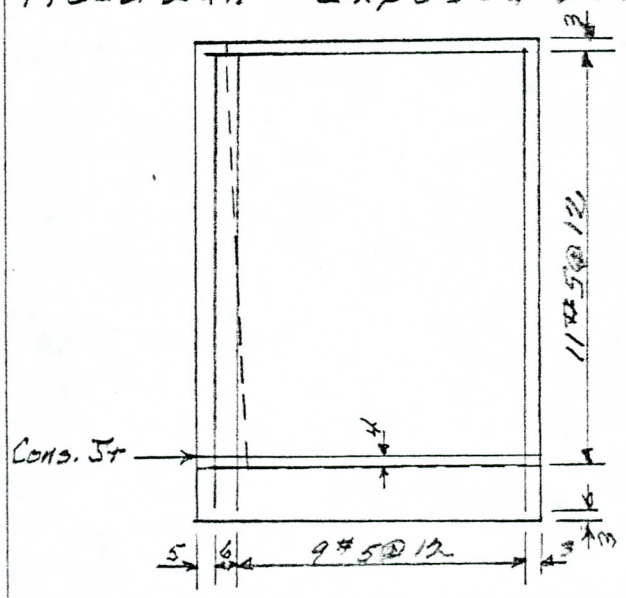
SUBJECT Emergency Spillway Design — SHEET 35 OF

## Head wall - Unexposed face




| | | | |
|---|---|---|---|
| H #10@12 | length | 3-0 + 3-0 | = 6-0 |
| H #8@12 | length | 5-9 + 3-0 | = 8-9 |
| V #6@12 | length | 9-0 + [illegible] | = 9-0 |
| V #4@12 | length | 2-0 + 1-3 | = 3-3 |

## Headwall - Exposed face




| | | | |
|---|---|---|---|
| H #5@12 | length | 8-9 | = 8-9 |
| V #5@12 | length | 12-0 | = 12-0 |

COMPUTATION SHEET

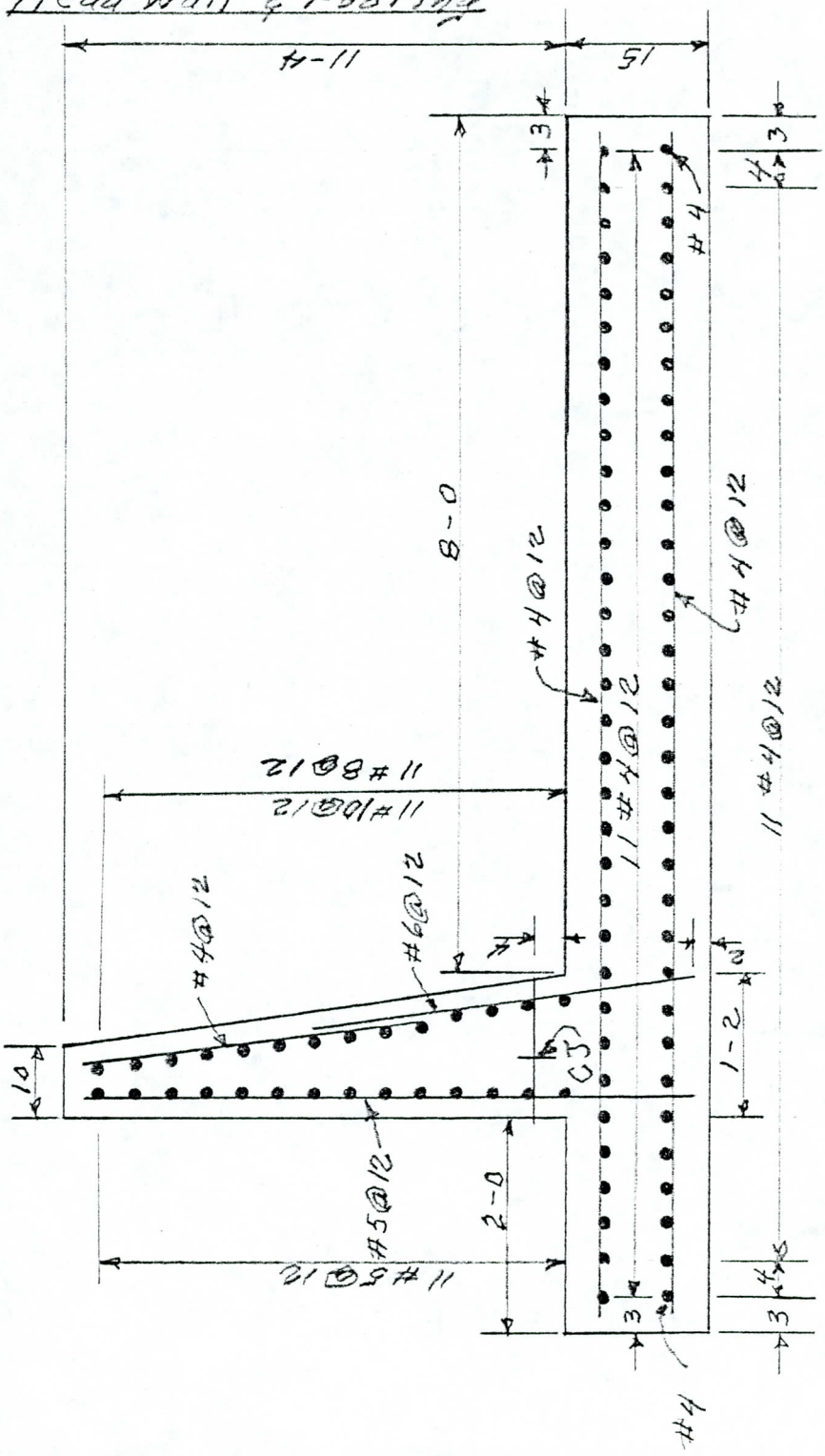
SCS-ENG-523 Rev. 8-69

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE



| STATE | | PROJECT | | | |
|---|---|---|---|---|---|
| Arizona | | Hayhurst Willow WP | | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. | |
| RJW - WEP | 4-7-80 | SWL | 6-80 | EP5 | |
| SUBJECT | | | | SHEET | OF |
| Emergency Spillway Design | | | | 36 | |

## Head Wall & Footing




ELEVATION

COMPUTATION SHEET

SCS-ENG-523 Rev. 8-69

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

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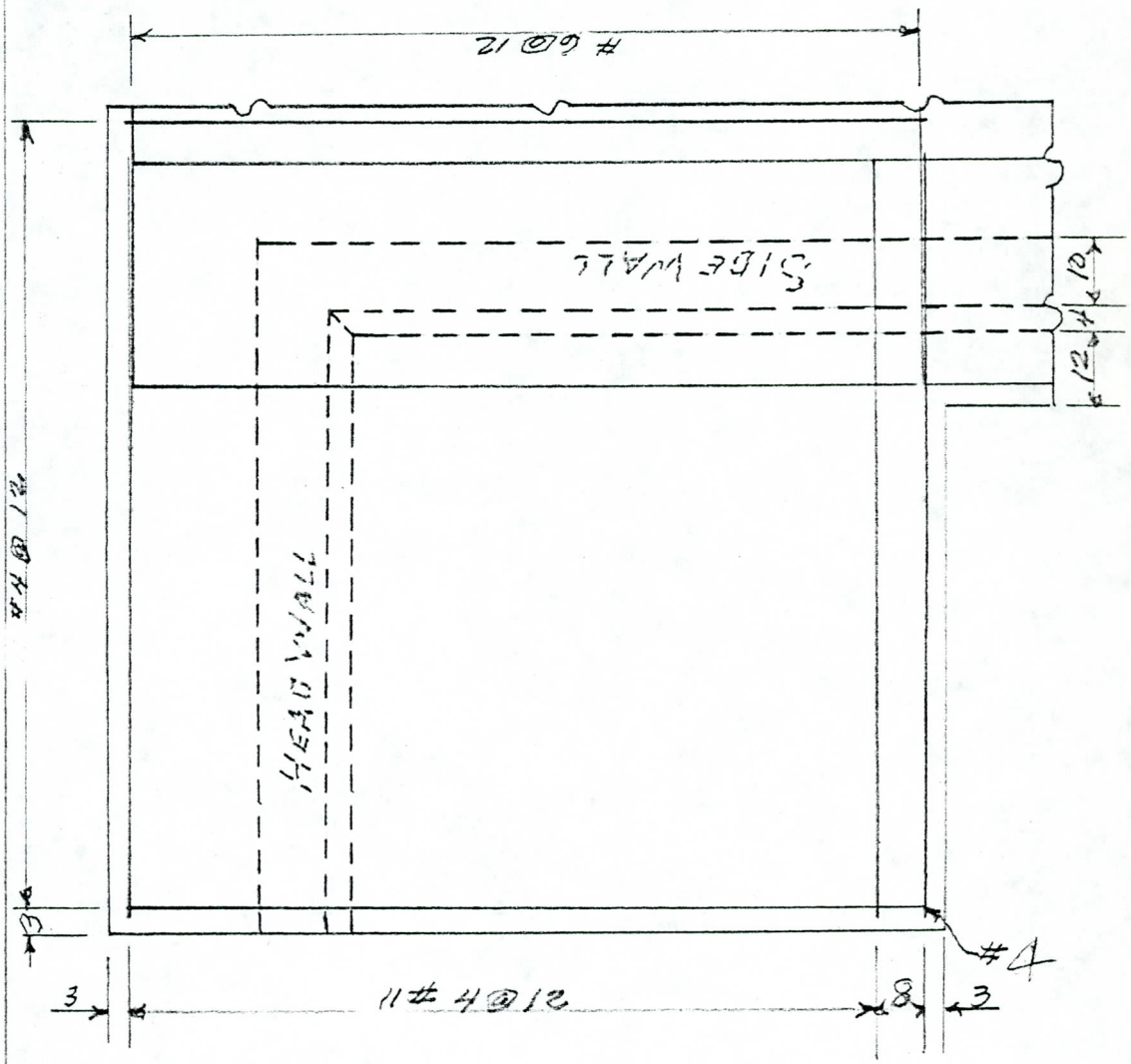
| STATE | | PROJECT | | | |
|---|---|---|---|---|---|
| Arizona | | Harquahala Valley WP | | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. | |
| RJW-W.E.P. | 4-7-80 | DWV | 6-80 | FRS | |
| SUBJECT | | | | SHEET 37 OF | |
| Emergency Spillway Design | | | | | |

Head Wall Footing




PLAN

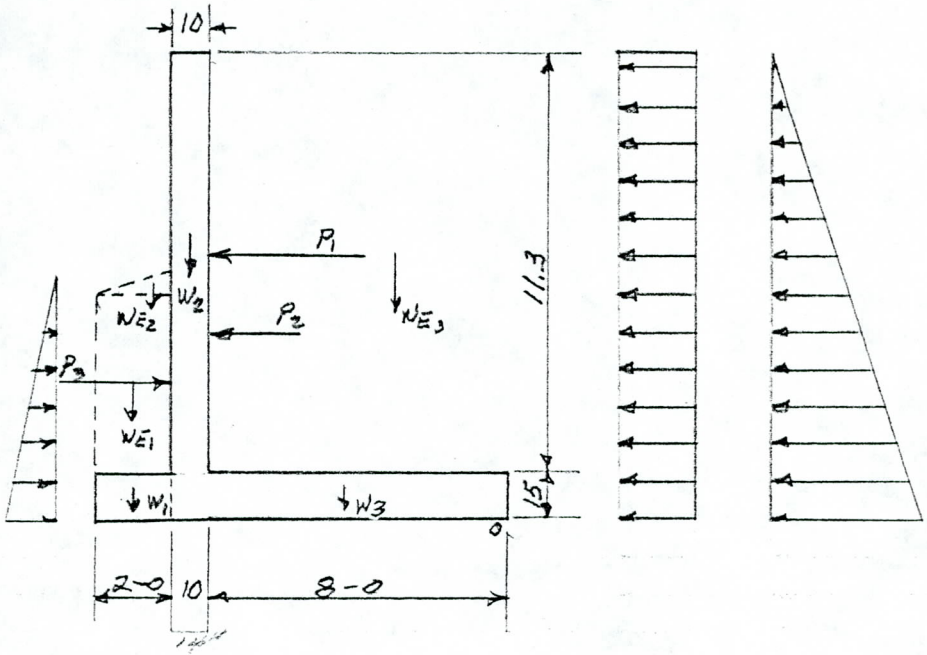
| STATE | | PROJECT | | |
|---|---|---|---|---|
| Arizona. | | Harquahala Valley WP | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. |
| RJW-WEP | 4-7-80 | SNW | 6-80 | FRS |
| SUBJECT | | | | SHEET 38 OF |
| Emergency Spillway Design | | | | |

Headwall Extension

The As-Built condition controls.

Headwall = 8 ft. Headwall Extension = 17 ft.

Try t = 10 in.




Determine stability against overturning

Take moments about o.

| Part | Weight | Force | Arm | Moment |
|---|---|---|---|---|
| W1<br>2.0(1.25)(150) | 375.0 | | 9.833 | 3687.375 |
| W2<br>0.833(12.55)(150)<br>total | 1568.123 | | 8.417 | 13198.887 |
| W3<br>1.25(8.0)(150) | 1500.0 | | 4.0 | 6000.0 |

STATE Arizona | PROJECT Harquahala Valley WP

BY RJW-WEP | DATE 4-7-80 | CHECKED BY GW | DATE 6-9? | JOB NO. FRS

SUBJECT Emergency Spillway Design | SHEET 39 OF

| | | | | |
|---|---|---|---|---|
| $W_{E1}$ $3.917(2.0)(130)$ | 1018.42 | | 9.833 | 10014.124 |
| $W_{E2}$ $0.667(2.0)(130)(0.5)$ | 86.71 | | 9.5 | 823.745 |
| $W_{E3}$ $8.0(11.3)(130)$ | 11752.0 | | 4.0 | 47008.0 |
| $P_1$ $2(130)(0.6)(12.55)$ | | 1957.8 | 6.275 | 12285.195 |
| $P_2$ $130(0.6)(12.55)^2(0.5)$ | | 6142.598 | 4.183 | 25694.487 |
| $P_3$ $-130(0.6)(5.834)^2(0.5)$ | | -1327.387 | 1.945 | -2581.768 |
| | 16300.253 | | | 116130.045 |

$$Z = \frac{116130.045}{16300.253} = 7.124 < \tfrac{2}{3}(10.833) = 7.222$$

STABLE

Try footing at end of wall = 6.0 ft.

Midpoint = $\frac{6.0+8.0}{2}$ = 7.0 ft.

Take moments about o

| Part | Weight | Force | Arm | Moment |
|---|---|---|---|---|
| $W_1$ $2.0(1.25)(150)$ | 375.0 | | 8.333 | 3124.875 |
| $W_2$ $0.833(12.55)(150)$ | 1568.123 | | 6.917 | 10846.707 |
| $W_3$ $1.25(7.0)(150)$ | 1312.5 | | 3.5 | 4593.75 |
| $W_{E1}$ $7.275(2)(130)$ | 1891.5 | | 8.833 | 16707.62 |

STATE Arizona | PROJECT Harquahala Valley WP
BY RJW-WEP | DATE 4-7-80 | CHECKED BY JWW | DATE 6-90 | JOB NO. ERS
SUBJECT Emergency Spillway Design | SHEET 40 OF

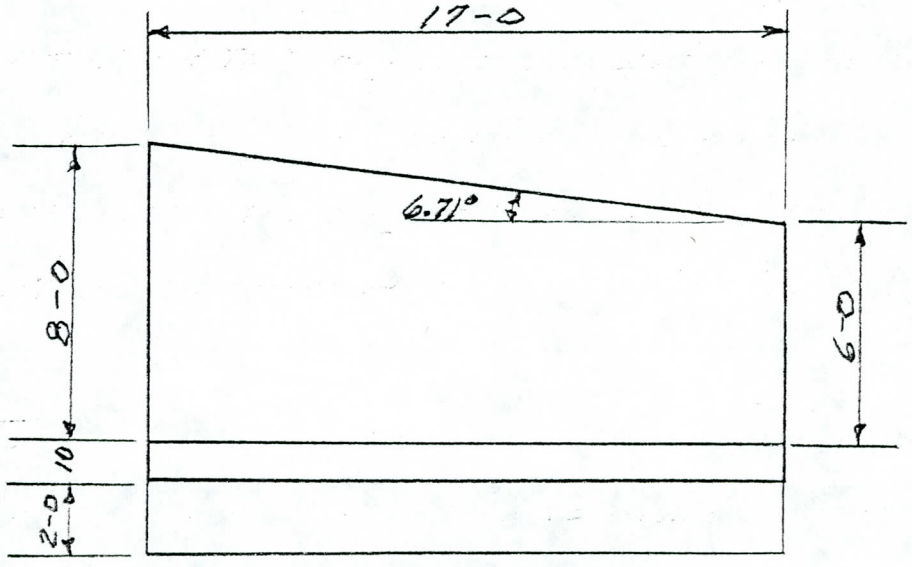
| | | | | |
|---|---|---|---|---|
| $W_{E_2}$ $0.667(2.0)(130)(0.5)$ | 86.71 | | 8.5 | 737.035 |
| $W_{E_3}$ $7.0(11.3)(130)$ | 10283.0 | | 3.5 | 35990.5 |
| $P_1$ $2(130)(0.6)(12.55)$ | | 1957.8 | 6.275 | 12285.195 |
| $P_2$ $130(0.6)(12.55)^2(0.5)$ | | 6142.598 | 4.183 | 25694.487 |
| $P_3$ $-130(0.6)(9.192)^2(0.5)$ | | -3295.222 | 3.064 | -10096.56 |
| | 15516.833 | | | 99883.609 |

$$Z = \frac{99883.609}{15516.833} = 6.437 < \frac{2}{3}(9.833) = 6.555$$

STABLE

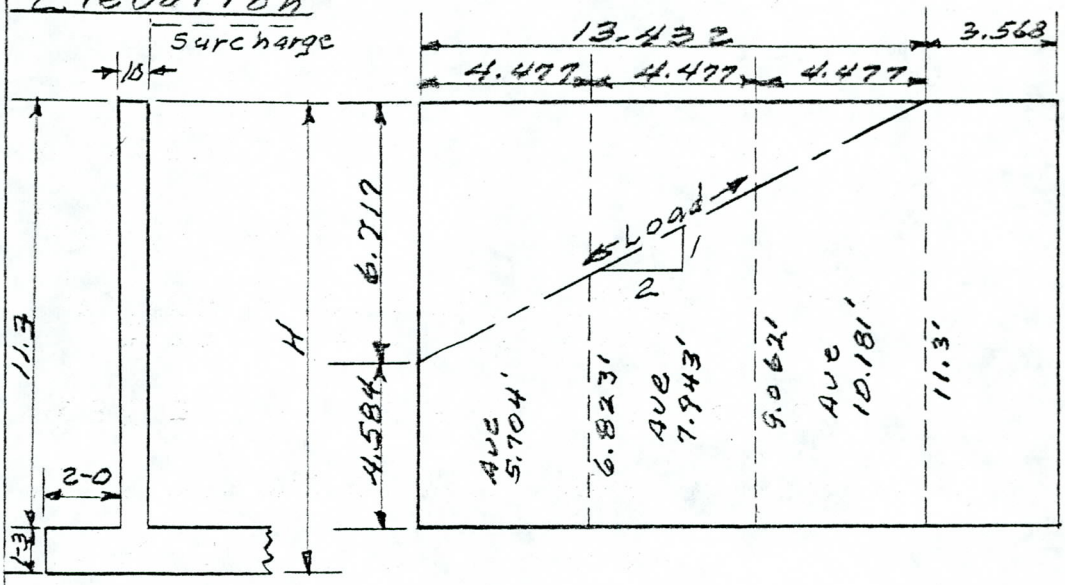
## Headwall Extension Dimensions

### Plan



| STATE | PROJECT | | |
|---|---|---|---|
| Arizona | Harquahala Valley WP | | |
| BY RJW-WEP / DATE 4-8-80 | CHECKED BY / DATE 4-80 | | JOB NO. EP5 |
| SUBJECT Emergency Spillway Design | | | SHEET 41 OF |

Elevation




Design Vertical wall

$P_T = P_1 + P_2 - P_3 \qquad z = 0$

$V = P = 2K\delta_m H_1 + K\delta_m \frac{H_2^2}{2} - K\delta_m \frac{H_3^2}{2} =$

$2(0.6)(130)(11.3) + 0.6(130)\frac{(11.3^2)}{2} - 0.6(130)\frac{(4584^2)}{2} =$

$1762.8 + 4979.91 - 819.509 = 5923.201$ lb.

$z_o = \frac{8V}{7du} = \frac{8(5923.201)}{7(7.5)(350)} = 2.58$ in.

$M = P_1\frac{(H_1)}{2} + P_2\frac{(H_2)}{3} - P_3\frac{(H_3)}{3} = 1762.8\left(\frac{11.3}{2}\right) + 4979.91\left(\frac{11.3}{3}\right) -$

$819.509\left(\frac{4.584}{3}\right) = 9959.82 + 18757.661 - 1252.210 =$

$27465.271$ ft-lb.

From ES-164

Minimum $d = 10.1$ in.

$t_{min} = 10.1 + 2.5 = 12.6$ in  Use 14 in. at bottom

$A_s = \frac{12M}{f_s j d} = \frac{12(27465.271)}{20000(7/8)(11.5)} = 1.64$ in$^2$

| STATE | | PROJECT | | |
|---|---|---|---|---|
| Arizona | | Harquahala Valley WP | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. |
| RJW-WEP | 4-8-80 | JWW | 6-80 | ERS |

SUBJECT Emergency Spillway Design — SHEET 42 OF

#10@9 $A_s = 1.69\ in^2$ $z_o = 5.32\ in.$
#9@6 $A_s = 2.00\ in^2$ $z_o = 7.09\ in.$

To develop As curves breakwall into four sections due to sloping load. Assume uniform effective fluid pressure for all sections.

| | Ave. H | Length |
|---|---|---|
| Section 1 | 5.704 | 4.477 |
| Section 2 | 7.943 | 4.477 |
| Section 3 | 10.181 | 4.477 |
| Section 4 | 11.3 | 3.568 |

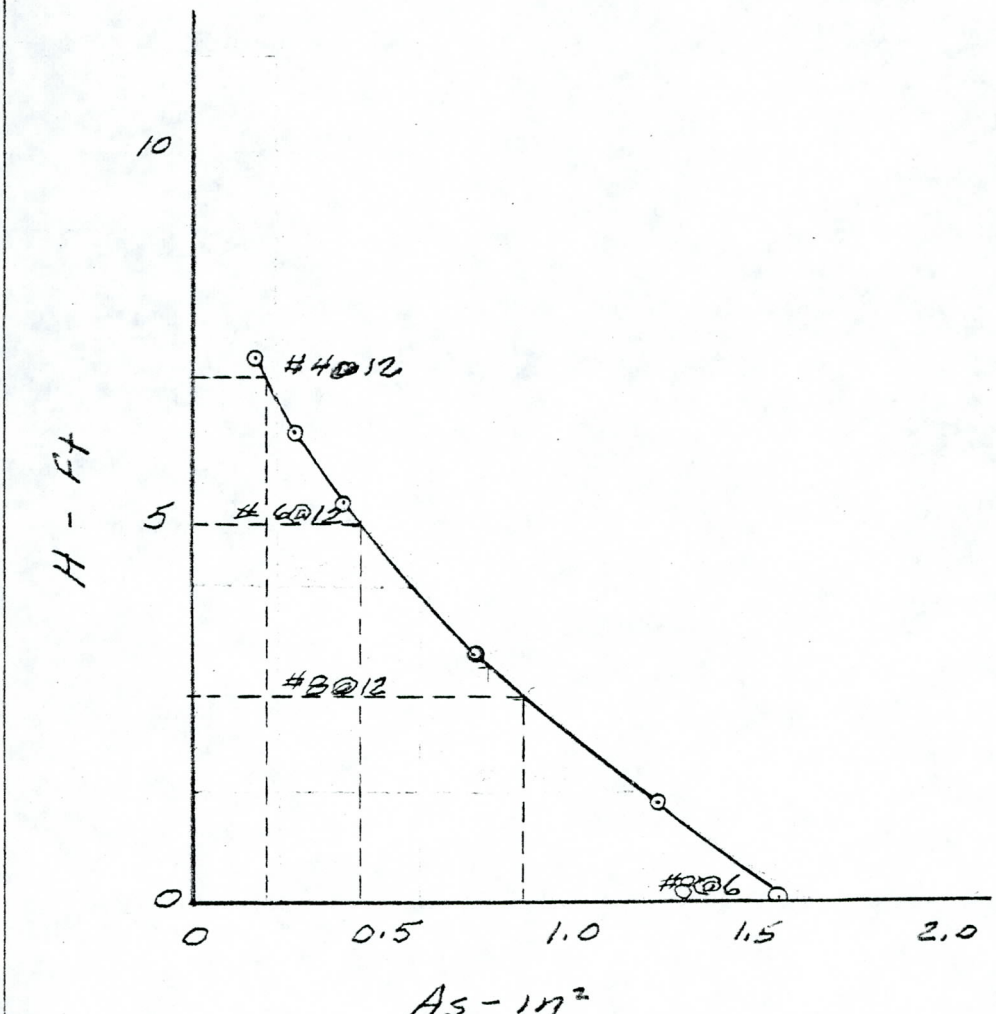
$$M = P_1\frac{H_1}{2} + P_2\frac{H_2}{3} - P_3\frac{H_3}{3} = \frac{2K\gamma_m H_1^2}{2} + \frac{K\gamma_m H_2^3}{6} - \frac{K\gamma_m H_3^3}{6}$$

$$M = 78H_1^2 + 13H_2^3 - 13H_3^3$$

Section 1 $H_1 = H_2 = 11.3$ $H_3 = 5.704$

| y | $y^2$ | $y^3$ | $y_3$ | $y_3^3$ | M | d | As |
|---|---|---|---|---|---|---|---|
| 11.3 | 127.69 | 1442.9 | 5.704 | 185.6 | 26304.7 | 11.5 | 1.57 |
| 10 | 100 | 1000 | 4.404 | 85.4 | 19689.8 | 11.04 | 1.22 |
| 8 | 64 | 512 | 2.404 | 13.9 | 11467.3 | 10.33 | 0.76 |
| 6 | 36 | 216 | 0.404 | 0.07 | 5615.1 | 9.63 | 0.40 |
| 5 | 25 | 125 | | | 3575.0 | 9.27 | 0.26 |
| 4 | 16 | 64 | | | 2080.0 | 8.92 | 0.16 |

| STATE | | PROJECT | | | |
|---|---|---|---|---|---|
| Arizona | | Harquahala Valley WP | | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. | |
| RJW-WEP | 4-8-80 | SML | 6-80 | ERS | |
| SUBJECT | | | | SHEET | OF |
| Emergency Spillway Design | | | | 43 | |




Section 2 $H_1 = H_2 = 11.3$ $H_3 = 7.943$

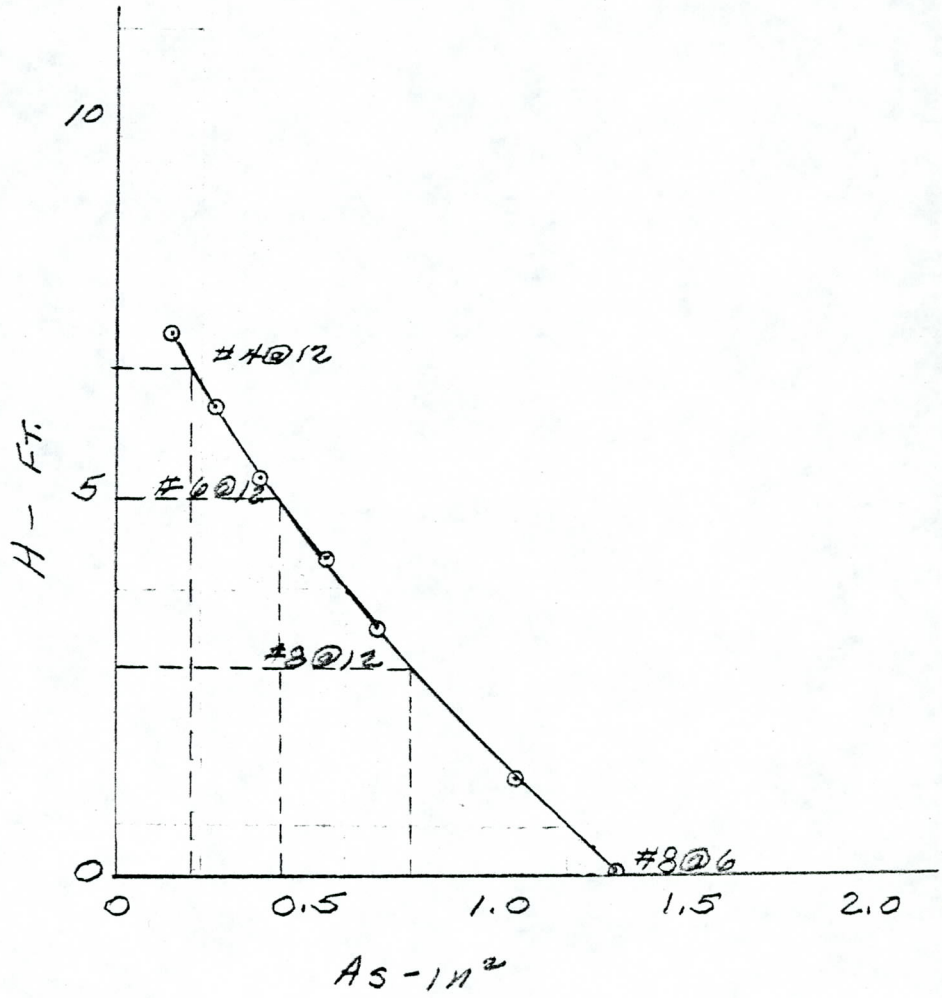
| y | $y^2$ | $y^3$ | $y_3$ | $y_3^3$ | M | d | As |
|---|---|---|---|---|---|---|---|
| 11.3 | 127.69 | 1442.9 | 7.943 | 501.1 | 22203.2 | 11.5 | 1.32 |
| 10 | 100 | 1000 | 6.643 | 293.2 | 16988.4 | 11.04 | 1.06 |
| 8 | 64 | 512 | 4.643 | 100.1 | 10346.7 | 10.33 | 0.69 |
| 7 | 49 | 343 | 3.643 | 48.3 | 7653.1 | 9.98 | 0.53 |
| 6 | 36 | 216 | 2.643 | 18.5 | 5375.5 | 9.63 | 0.38 |

STATE Arizona | PROJECT Harquahala Valley WP

BY RJW-WEP | DATE 4-8-80 | CHECKED BY SMV | DATE 4-10 | JOB NO FRS

SUBJECT Emergency Spillway Design | SHEET 44 OF

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 5 | 25 | 125 | 1.643 | 4.4 | 3517.8 | 9.27 | 0.26 |
| 4 | 16 | 64 | 0.643 | 0.3 | 2076.1 | 8.92 | 0.16 |




Section 3 $H_1 = H_2 = 11.3$ $H_3 = 10.181$

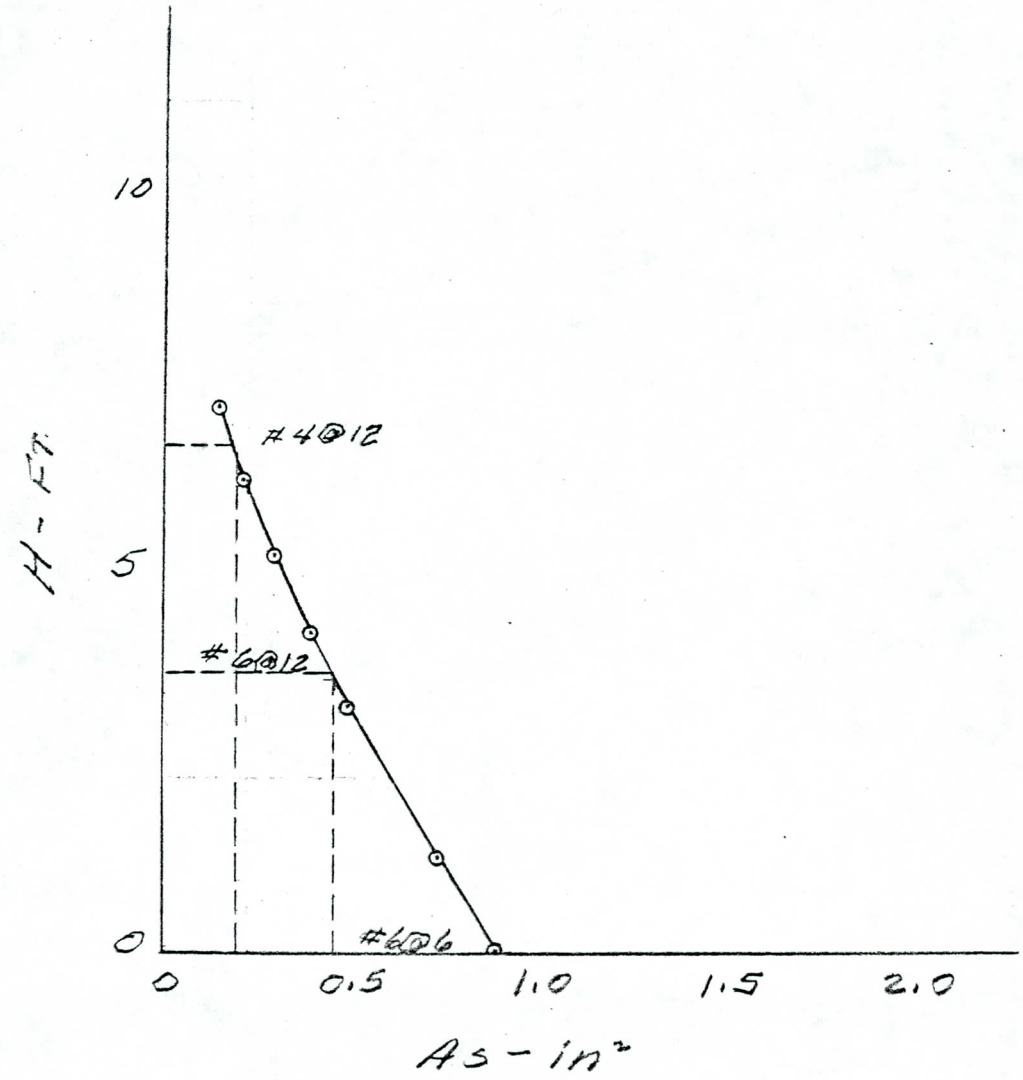
| y | $y^2$ | $y^3$ | $y_3$ | $y_3^3$ | M | d | As |
|---|---|---|---|---|---|---|---|
| 11.3 | 127.69 | 1442.9 | 10.181 | 1055.3 | 14998.6 | 11.5 | 0.89 |
| 10 | 100 | 1000 | 8.881 | 700.5 | 11693.5 | 11.04 | 0.73 |
| 8 | 64 | 512 | 6.881 | 325.8 | 7412.6 | 10.33 | 0.49 |

STATE Arizona | PROJECT Harquahala Valley WP

BY RJW-WEP | DATE 4-8-80 | CHECKED BY SW | DATE 6-80 | JOB NO. ERS

SUBJECT Emergency Spillway Design | SHEET 45 OF

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 49 | 343 | 5.881 | 203.4 | 5636.8 | 9.98 | 0.37 |
| 6 | 36 | 216 | 4.881 | 116.3 | 4104.1 | 9.63 | 0.29 |
| 5 | 25 | 125 | 3.881 | 58.5 | 2814.5 | 9.27 | 0.21 |
| 4 | 16 | 64 | 2.881 | 23.9 | 1769.3 | 8.92 | 0.14 |

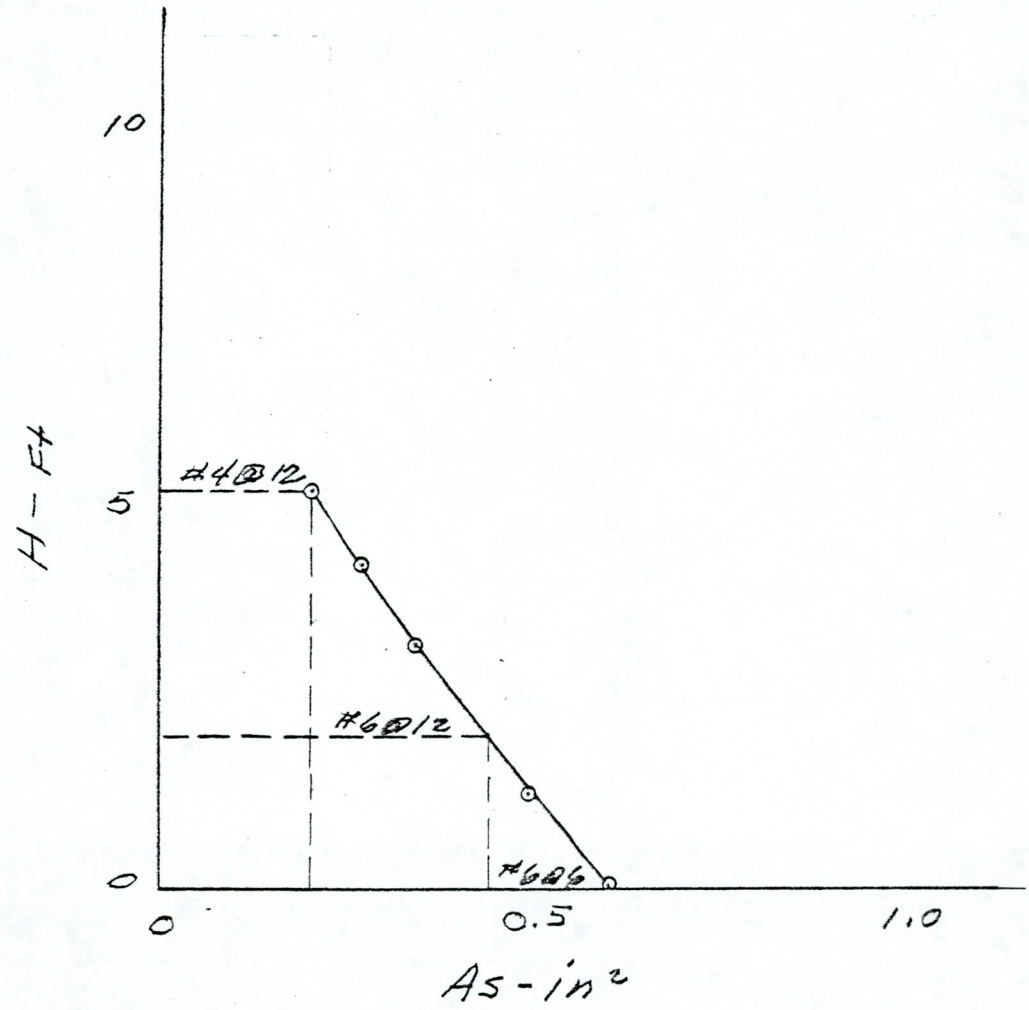


| STATE | | PROJECT | | |
|---|---|---|---|---|
| Arizona | | Harquahala Valley WP | | |
| BY | DATE | CHECKED BY | DATE | JOB NO |
| RJW-WEP | 4-8-80 | SDW | 4-10 | FRS |

SUBJECT Emergency Spillway Design — SHEET 46 OF

Section 4 $H_1 = H_2 = H_3 = 11.3$ $\therefore M = 78H^2$

| H | y | $y^2$ | M | d | $A_s$ |
|---|---|---|---|---|---|
| 0 | 11.3 | 127.69 | 9959.8 | 11.5 | 0.59 |
| 1.3 | 10 | 100 | 7800 | 11.04 | 0.48 |
| 3.3 | 8 | 64 | 4992 | 10.33 | 0.33 |
| 4.3 | 7 | 49 | 3822 | 9.98 | 0.26 |
| 5.3 | 6 | 36 | 2808 | 9.63 | 0.20 |



| STATE | PROJECT | | | |
|---|---|---|---|---|
| Arizona | Harquahala Valley WP | | | |
| BY RJW-WEP | DATE 4-8-80 | CHECKED BY | DATE 6-80 | JOB NO. FRS |
| SUBJECT Emergency Spillway Design | | | | SHEET 47 OF |

Horizontal Steel (Unexposed face)

Temp. & Shrinkage steel

$A_s = 0.001(12)(14) = 0.17 in^2$ Use # 4 @ 12

Vertical Steel (Exposed face)

Temp. & Shrinkage Steel

$A_s = 0.002(12)(14) = 0.34 in^2$ #6 @ 12 to 3.5 ft above footing then use #5 @ 12

Horizontal Steel (Exposed face)

Temp. & Shrinkage steel

$A_s = 0.002(12)(14) = 0.34 in^2$ #6 @ 12 to 3.5 ft. above footing then use #5 @ 12

Design Footing

Loads on embankment section (downstream)

$$P = \frac{V}{A}\left(1 \pm \frac{6e}{d}\right)$$

$V = 16300.253$ lb. (From sheet 39)

$A = (8 + 1.167 + 2)1 = 11.167 ft^2$ $d = 11.167$ ft.

$Z = 7.124$ ft. (From sheet 39)

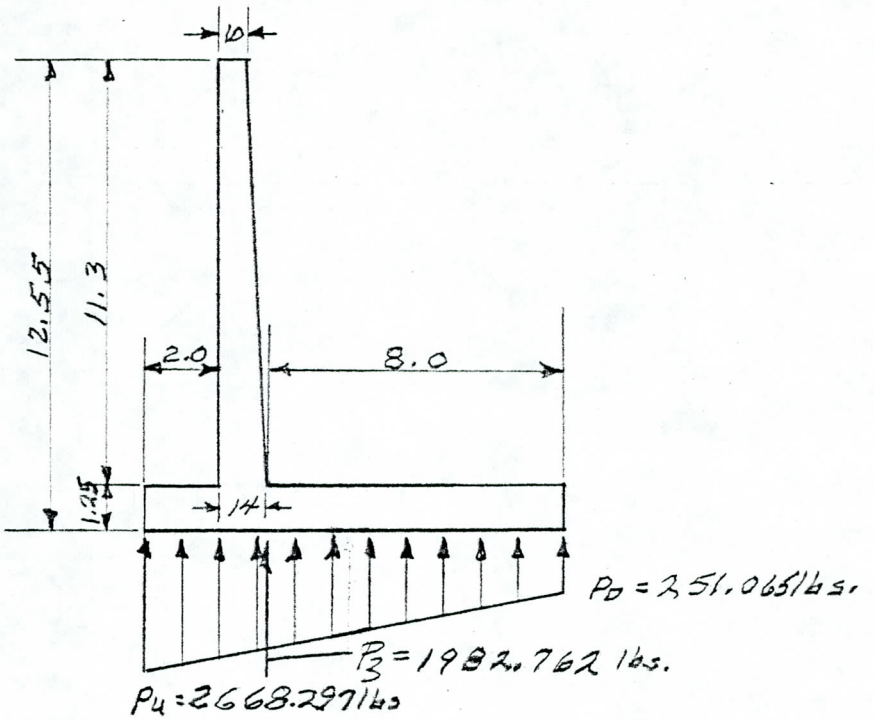
$$e = \left(Z - \frac{d}{2}\right) = 7.124 - \frac{11.167}{2} = 1.541 \text{ ft.}$$

$$P = \frac{16300.253}{11.167}\left(1 \pm \frac{6(1.541)}{11.167}\right) = 1459.681(1 \pm 0.828) =$$

$P_u = 1459.681(1.828) = 2668.297$ lbs.

$P_d = 1459.681(0.172) = 251.065$ lbs.

| STATE | | PROJECT | | |
|---|---|---|---|---|
| Arizona | | Harquahala Valley WP | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. |
| RJW-WEP | 4-9-80 | SMC | 6-80 | ERS |
| SUBJECT | | | | SHEET 48 OF |
| Emergency Spillway Design | | | | |




$P_3 = 251.065 + \frac{8}{11.167}(2668.297 - 251.065) = 1982.762$ lbs.

$W = 11.3(130) + 1.25(150) = 1656.5$ lbs./ft²

Moment and Shear

$$M = \frac{W8^2}{2} - \frac{P_0 8^2}{2} - \frac{P_3 - P_0}{2}\left(\frac{1}{3}\right)(8^2) =$$

$$\frac{1656.5(64)}{2} - \frac{251.065(64)}{2} - (1982.762 - 251.065)\left(\frac{64}{6}\right) =$$

$$53008 - 8034.08 - 18471.435 = 26502.485 \text{ ft-lb.}$$

$$V = \frac{W(8)}{2} - \frac{(P_3 + P_0)(8)}{2} = 4(1656.5 - 1982.762 - 251.065) =$$

$$-2309.308 \text{ lbs.}$$

$d = 15 - 3.5 = 11.5$ in.

$$A_s = \frac{12M}{f_s j d} = \frac{12(26502.485)}{20000(7/8)(11.5)} = 1.58 \text{ in}^2$$

$$\Sigma_0 = \frac{8V}{\pi d u} = \frac{8(2309.308)}{7(11.5)(350)} = 0.656 \text{ in.}$$

| STATE | | PROJECT | | |
|---|---|---|---|---|
| Arizona | | Harquahala Valley WP | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. |
| RJW-WEP | 4-9-80 | [illegible] | 6-80 | FRS |
| SUBJECT | | | | SHEET 42 OF |
| Emergency Spillway Design | | | | |

#11 @ 12 $A_s = 1.56\ in.^2$ $z_o = 4.43\ in.$
#10 @ 9 $A_s = 1.69\ in.^2$ $z_o = 5.32\ in.$
#8 @ 6 $A_s = 1.57\ in.^2$ $z_o = 6.23\ in.$

Top face (unexposed)

Temp. and Shrinkage Steel

$A_s = 0.001(12)(15) = 0.18\ in^2$ #4 @ 12

Bottom face (unexposed)

Temp. and Shrinkage Steel

$A_s = 0.001(12)(15) = 0.18\ in^2$ #4 @ 12 both directions

COMPUTATION SHEET

SCS–ENG–523 Rev. 8–69

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

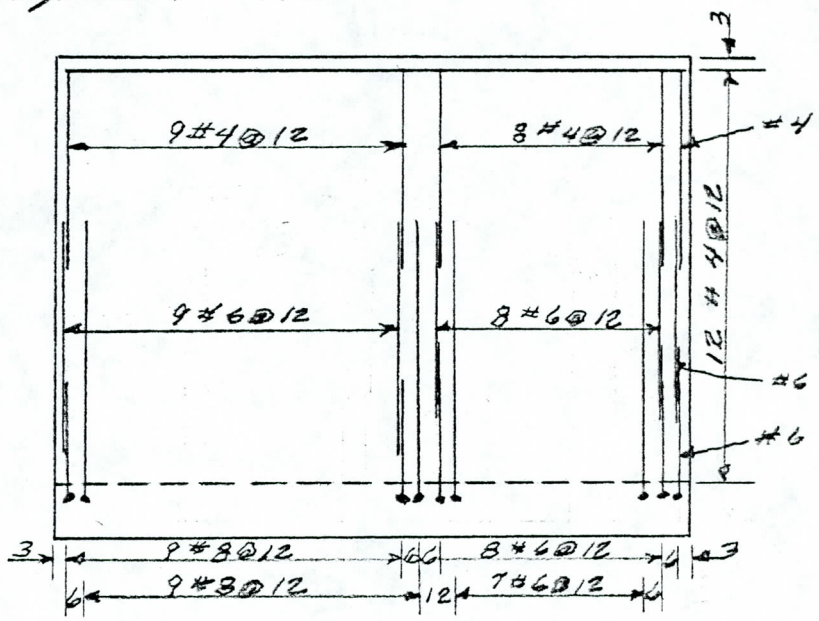


| STATE | | PROJECT | | |
|---|---|---|---|---|
| Arizona | | Harquahala Valley WP | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. |
| W.E. Payne | 5-3-80 | SDW | 6-80 | ERS |

SUBJECT Emergency Spillway Design — SHEET 50 OF

Headwall Extension

Unexposed Face



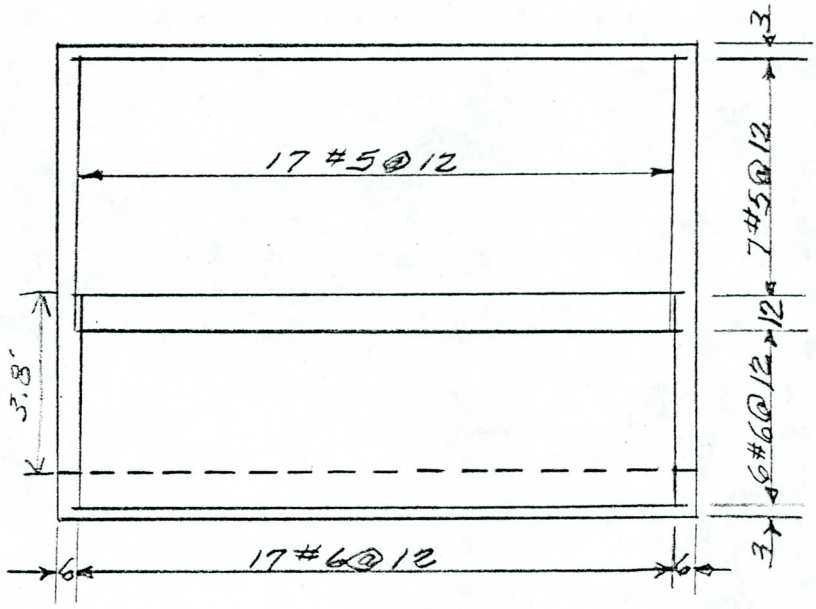

| | | | |
|---|---|---|---|
| V #8@12 length | 3-0 + 1-3 | = | 4-3 |
| V #8@12 length | 7-0 + 1-3 | = | 8-3 |
| V #6@12 length | 4-0 + 0-9 | = | 4-9 |
| V #6@12 length | 7-3 + 0-9 | = | 8-0 |
| V #6@12 length | 6-3 | = | 6-3 |
| V #6@12 length | 5-3 | = | 5-3 |
| V #4@12 length | 5-4 | = | 5-4 |
| H #4@12 length | 16-6 | = | 16-6 |

| STATE | | PROJECT | | |
|---|---|---|---|---|
| Arizona | | Harquahala Valley WP | | |
| BY | DATE | CHECKED BY | DATE | JOB NO |
| W.E. Payne | 5-3-80 | BWL | 6-80 | EPS |

SUBJECT Emergency Spillway Design SHEET 51 OF

## Headwall Extension

### Exposed Face




| | | | | |
|---|---|---|---|---|
| V | #6@12 | length | 5-0 + 0-9 | = 5-9 |
| V | #5@12 | length | 7-6 + 0-9 | = 8-3 |
| H | #6@12 | length | 16-6 | = 16-6 |
| H | #5@12 | length | 16-6 | = 16-6 |

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COMPUTATION SHEET

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U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

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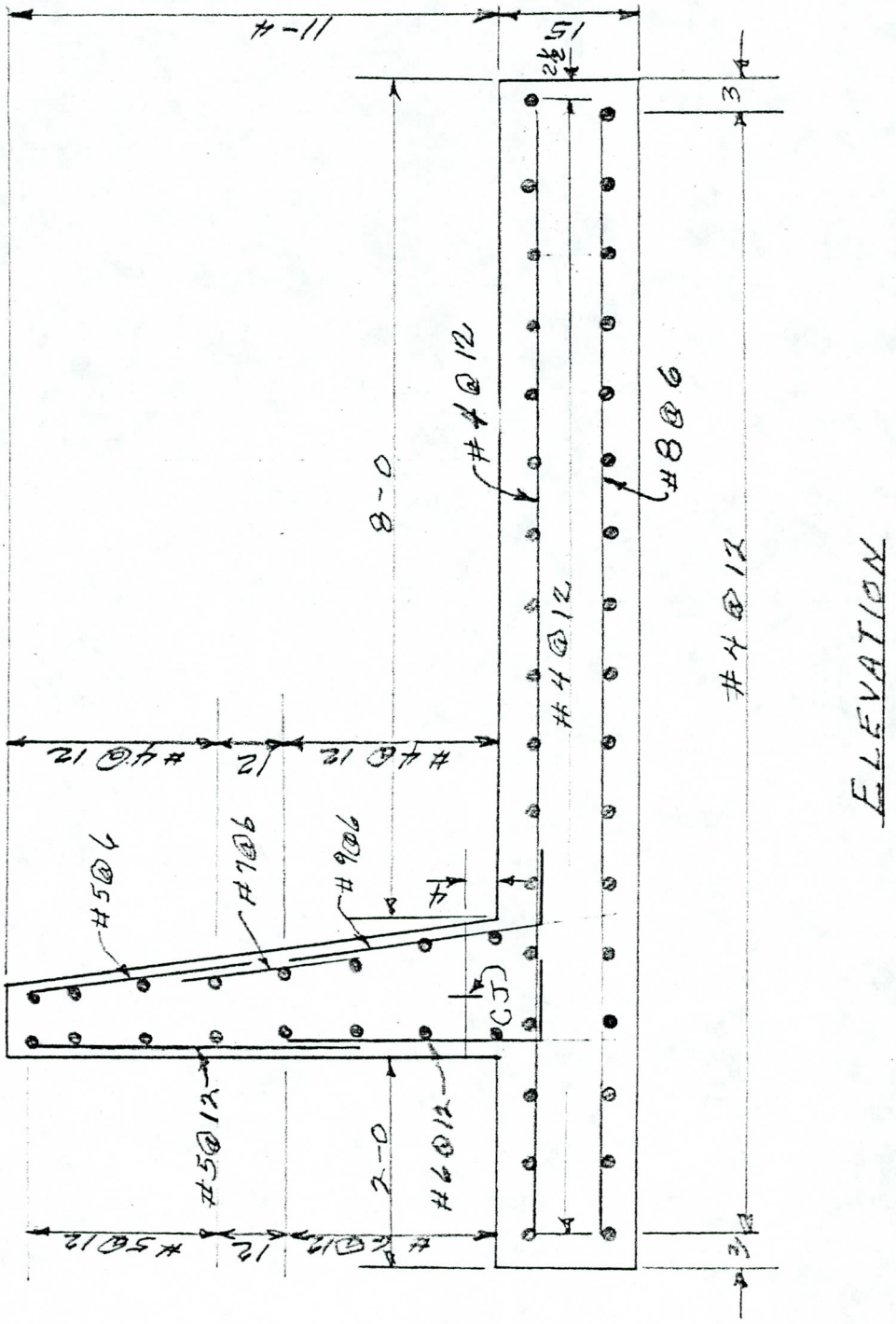
| STATE | | PROJECT | | |
|---|---|---|---|---|
| Arizona | | Harquahala Valley WP | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. |
| RJW-WEP | 4-9-80 | CMV | 6-80 | ERS |

SUBJECT Emergency Spillway Design — SHEET 52 OF

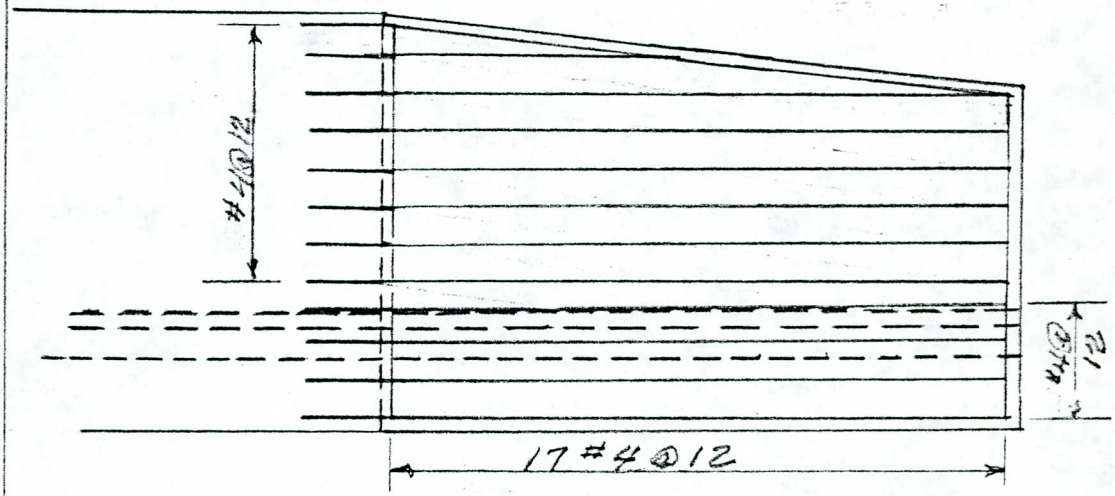
## Headwall Extension and Footing



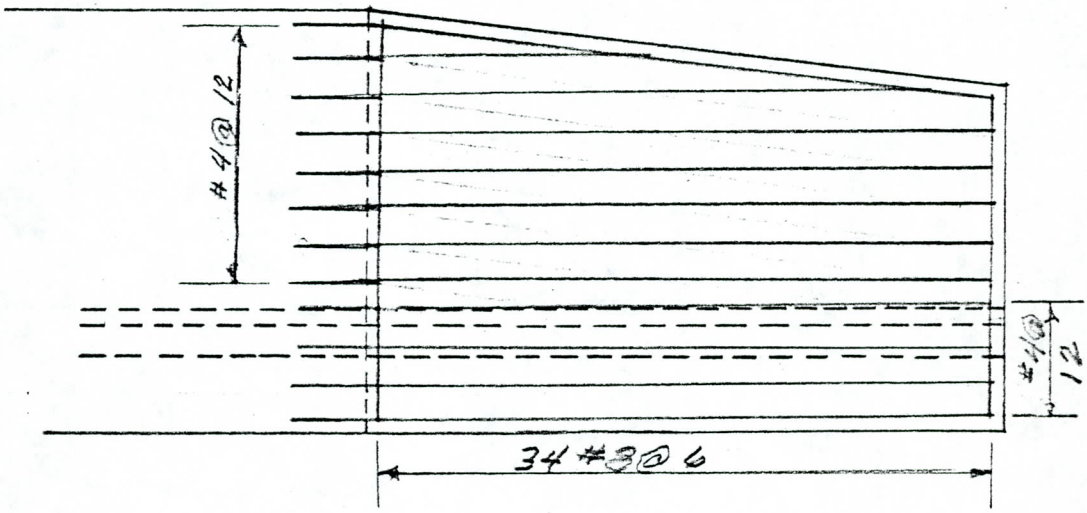
| STATE | | PROJECT | | |
|---|---|---|---|---|
| Arizona | | Harquahala Valley WP | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. |
| RJW-WEP | 4-9-80 | SWL | 6-80 | FRS |
| SUBJECT | | | | SHEET 53 OF |
| Emergency Spillway Design | | | | |

## Headwall Extention Footing

### Top Face



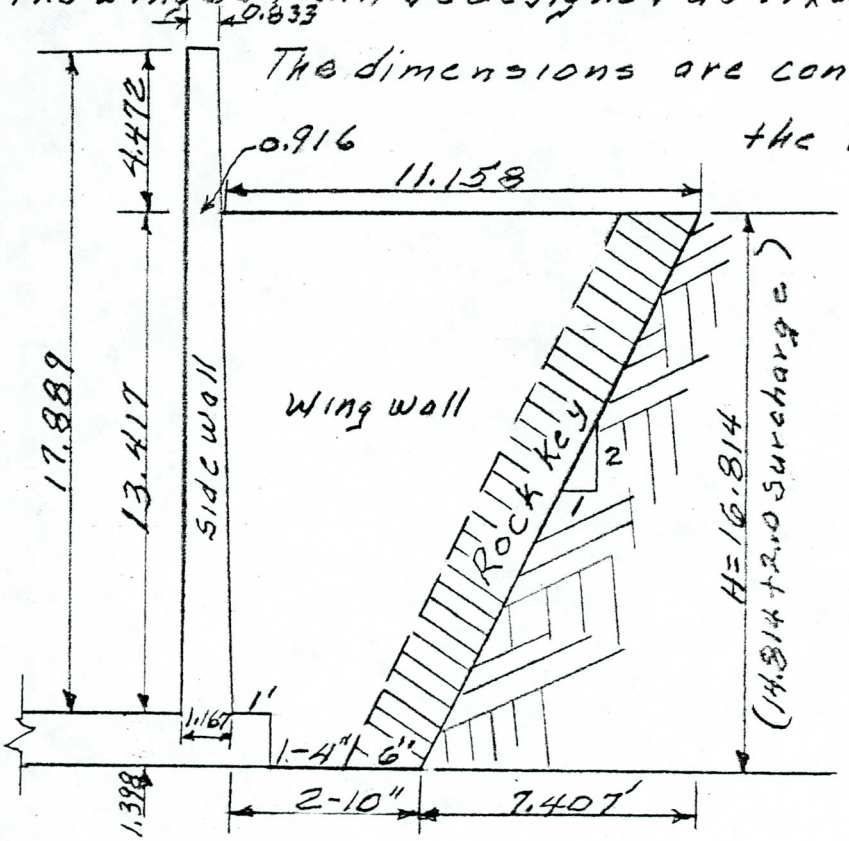

### Bottom Face



| STATE | | PROJECT | | |
|---|---|---|---|---|
| Arizona | | Harquahala Valley WP | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. |
| W.E. Payne | 5-3-80 | [illegible] | 6-80 | ERS |
| SUBJECT | | | | SHEET 54 OF |
| Emergency Spillway Design | | | | |

## Design Wingwalls

The wingwalls will be used to retain the earth backfill next to the chute walls on the 2:1 slope. The wingwall will be attached to the chute sidewall and keyed into the rock. The wingwall will be designed as fixed on both ends.




The dimensions are converted to the vertical.

Surcharge = 2.0 ft.

K = 0.6

$\gamma_m$ = 130 pcf

$\gamma_{soil}$ = 136 pcf

$\gamma_b$ = 73 pcf

Loading will be uniform. Sliding and overturning will not be a problem due to key into rock.

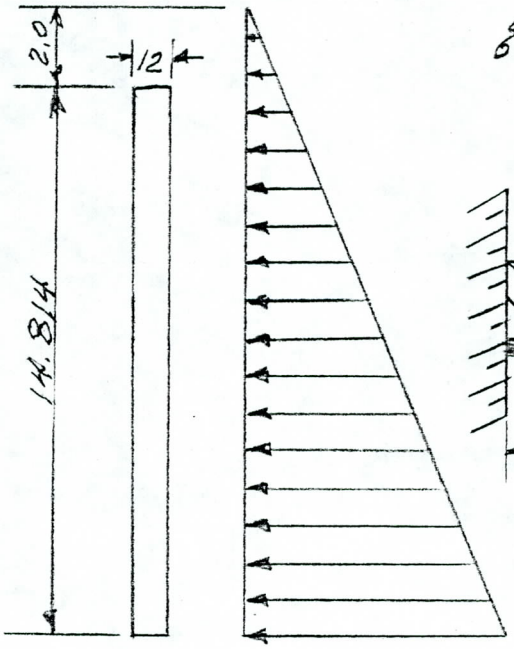
| STATE | PROJECT | | |
|---|---|---|---|
| Arizona | Harquahala Valley WP | | |
| BY / DATE | CHECKED BY / DATE | JOB NO | |
| W.E. Payne 5-3-80 | [illegible] 6-30 | FRS | |

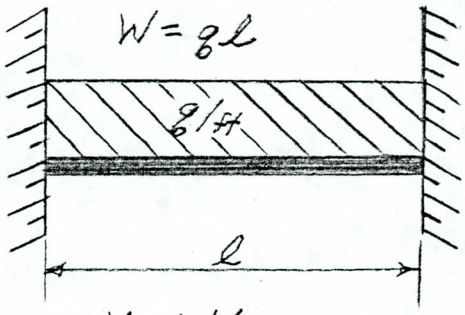
SUBJECT Emergency Spillway Design — SHEET 55 OF

Try a 12 inch wing wall

$\gamma_{sat} = 136$ pcf

$q = 0.6(136)y = 81.6y$




$V = W/2$

$-M = Wl/12$

$+M = Wl/24$

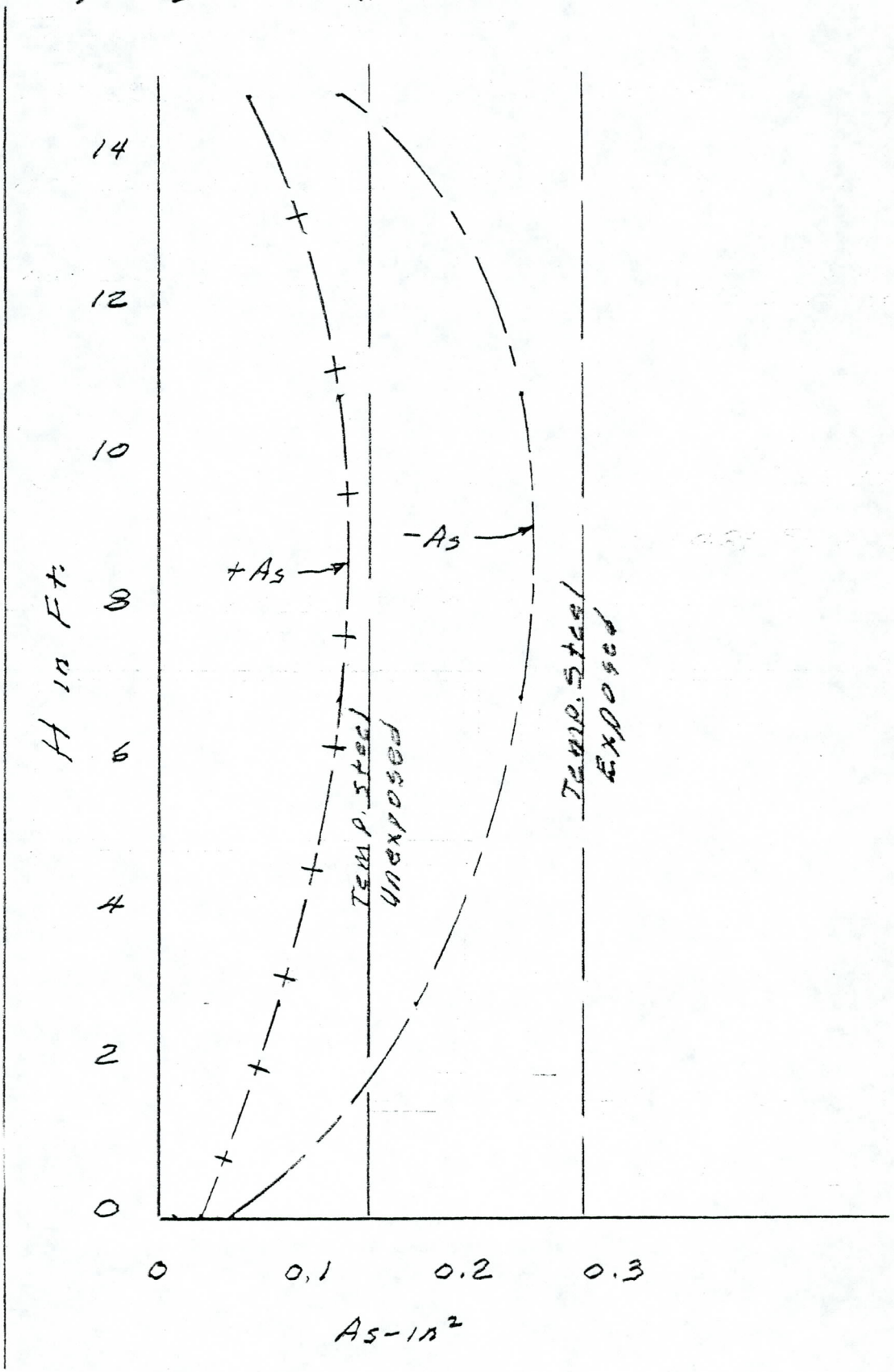
| H | y | l | W | −M | +M | −As | +As | Σo |
|---|---|---|---|---|---|---|---|---|
| 14.814 | 2 | 11.158 | 1821.0 | 1693.2 | 846.6 | 0.12 | 0.06 | 0.31 |
| 10.814 | 6 | 9.074 | 4442.6 | 3357.3 | 1679.7 | 0.24 | 0.12 | 0.76 |
| 6.814 | 10 | 6.991 | 5704.7 | 3324.5 | 1661.7 | 0.24 | 0.12 | 0.93 |
| 2.814 | 14 | 4.907 | 5605.8 | 2292.3 | 1146.2 | 0.17 | 0.08 | 0.96 |
| 0 | 16.814 | 2.5 | 3430.1 | 714.6 | 357.3 | 0.05 | 0.03 | 0.57 |

Temp. Steel Exposed face $= 0.002(12)(12) = 0.29$ in²

Unexposed face $= 0.001(12)(12) = 0.14$ in²

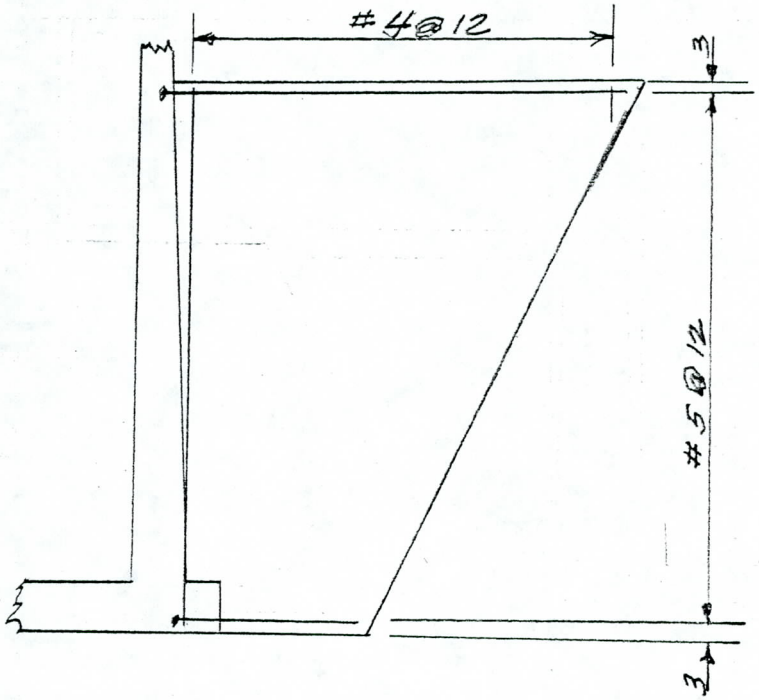
| STATE | | PROJECT | | |
|---|---|---|---|---|
| Arizona | | Harquahala Valley WP | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. |
| W.E. Payne | 5-3-80 | [illegible] | 7-1-80 | EAS |

SUBJECT Emergency Spillway Design — SHEET 56 OF

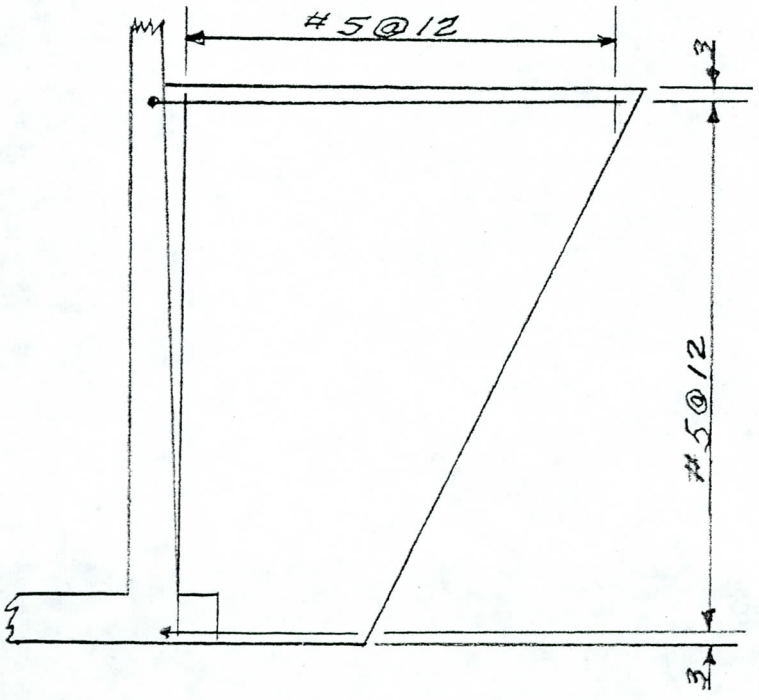


| STATE | | PROJECT | | |
|---|---|---|---|---|
| Arizona | | Harquahala Valley W.P. | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. |
| W.E. Payne | 5-3-80 | [illegible] | 6-30 | FRS |
| SUBJECT | | | | SHEET 57 OF |
| Emergency Spillway Design | | | | |

## Steel Layout - Unexposed Face




## Exposed Face



COMPUTATION SHEET

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| STATE | | PROJECT | | |
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| Arizona | | Harquahala Valley WP | | |
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| W. E. Payne | 5-3-80 | CHD | 7/15/80 | FRS |

SUBJECT Emergency Spillway Design SHEET 58 OF

Check Uplift at Entrance on one section of Paving.

| Part | | | Weight |
|---|---|---|---|
| Paving | 150.0 x 25.0 x 14.833 x 0.917 | | 51006.979 |
| Cutoff | 150.0 x 1.0 x 25.0 x 3.0 | | 11250.0 |
| Water | 62.4 x 11.3 x 25.0 x 14.833 | | 261476.124 |
| Uplift | 62.4 x 11.3 x 25.0 x 14.833 | 261476.124 | 323733.103 |

$$\text{Ratio} = \frac{323733.103}{261476.124} = 1.24 \quad \text{O.K.}$$

Sidewall and Apron

| Part | | | Weight |
|---|---|---|---|
| Apron | 150.0 x 1.25 x 14.833 x 14.667 | | 40791.677 |
| Sidewall | $150.0 \times \frac{11.3}{2} \times 1.0 \times 14.833$ | | 12570.963 |
| Cutoff | 150.0 x 14.667 x 1.0 x 3.0 | | 6600.15 |
| Soil | 136.0 x 11.3 x 1.0 x 13.666 | | 21001.909 |
| Water | 62.4 x 14.833 x 11.3 x 12.5 | | 130738.065 |
| Uplift | 62.4 x 14.833 x 11.3 x 14.667 | 153402.812 | 211702.766 |

| STATE | PROJECT | | | |
|---|---|---|---|---|
| Arizona | Harquahala Valley WP | | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. |
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| SUBJECT | | | | SHEET 58 OF |
| Emergency Spillway Design | | | | |

Ratio = $\frac{211,702.766}{153402.812}$ = 1.38 O.K.

Headwall and Footing

| Part | | | Weight |
|---|---|---|---|
| Headwall | $150.0 \times \frac{11.3}{2} \times 8.0 \times 1.0$ | | 6780.0 |
| Footing | $150.0 \times 1.25 \times 8.0 \times 11.167$ | | 16750.5 |
| Cut-off | $150.0 \times 1.0 \times 3.0 \times 8.0$ | | 3600.0 |
| Soil | $136.0 \times 11.3 \times 8.0 \times 8.0$ | | 98355.2 |
| Soil | $136.0 \times \frac{4.584}{2} \times 2.0 \times 8.0$ | | 4987.392 |
| Water | $62.4 \times 2.0 \times 8.0 \times 11.3$ | | 11281.92 |
| Uplift | $62.4 \times 11.3 \times 8.0 \times 11.167$ | 62992.6 | 141755.012 |

Ratio = $\frac{141755.012}{62992.6}$ = 2.25 O.K.

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| STATE | | PROJECT | | |
|---|---|---|---|---|
| Arizona | | Harquahala Valley W.P. | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. |
| W.E. Payne | 5-3-80 | CAG | 7/15/80 | E.R.S. |

SUBJECT Emergency Spillway Design — SHEET 60 OF

Headwall Extension and Footing

| Part | | | Weight |
|---|---|---|---|
| Headwall Ext. | $150.0 \times \frac{11.3}{2} \times 17.0 \times 1.0$ | | 14407.5 |
| Footing | $150.0 \times 1.25 \times 17.0 \times \frac{(9.167 + 11.167)}{2}$ | | 32407.313 |
| Soil | $136.0 \times 11.3 \times 17.0 \times \frac{(9.167 + 11.167)}{2}$ | | 265618.975 |
| Soil | $136.0 \left[\frac{(4.584 + 11.3)}{2} 13.341 + 11.3 \times 3.568\right]$ | | 19893.077 |
| Water | $62.4 \times 17.0 \times 2.0 \times 11.3$ | | 23974.08 |
| Uplift | $62.4 \times 11.3 \times 17.0 \times \frac{(9.167 + 11.167)}{2}$ | 121872.236 | 356300.945 |

$$\text{Ratio} = \frac{356300.945}{121872.236} = 2.92 \quad \text{O.K.}$$

| STATE | PROJECT | | | |
|---|---|---|---|---|
| Arizona | Harquahala Valley WP | | | |
| BY W.E.Payne | DATE 5-13-80 | CHECKED BY SW | DATE 6-80 | JOB NO. FRS |
| SUBJECT Emergency Spillway Design | | | SHEET 61 OF | |

## Baffle Block Design

The Water surface profile in the chute was run on the Monroe 1880 to determine the depth of water on the 2nd row of blocks to provide the load on the blocks.

| | | |
|---|---|---|
| 16,000.00 | Q | Q |
| 0.0140 | n | n |
| 0.500000 | S | SI |
| 0.00 | Eddy Loss | t |
| 1.10 | Head Loss | A |
| 100.00 | Sta. | S1 |
| 1.00 | Elev. | e |
| 150.00 | W | X |
| 0.00 | Z | Z |
| 7.070 | D1 | D1 |
| 15.08 | Vel. | V |
| 7.30 | Dc | DC |
| 1.00 | Froude | F |
| 115.00 | Sta. | S2 |
| 2.50 | Elev. | e |
| 150.00 | W | X |
| 0.00 | Z | Z |
| 3.631 | D2 | D2 |
| 29.37 | Vel. | V |
| 7.30 | Dc | DC |
| 2.71 | Froude | F |

Flow is diverted perpendicular by each set of blocks up and to the side. Model Studies show that the velocity through out the baffled section averages Vc. Water diverted by the first set of blocks will impede the flow to the second set of blocks so d will increase while V1 is decreased.

| STATE | PROJECT | | | |
|---|---|---|---|---|
| Arizona. | Harquahala Valley WP | | | |
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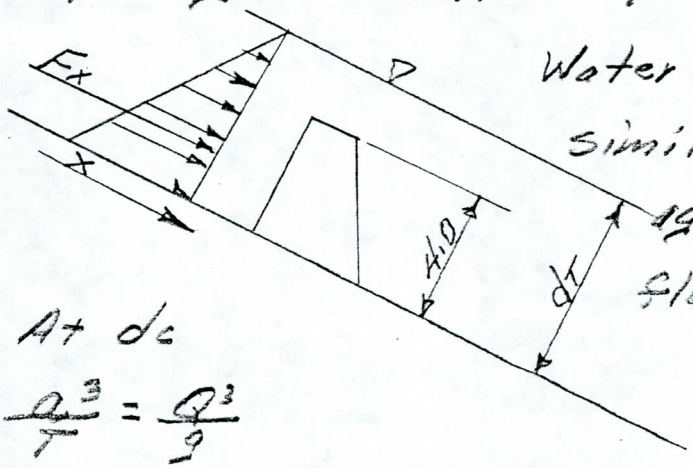
| W.E. Payne | 5-13-80 | [illegible] | 6-80 | ERS. |

SUBJECT Emergency Spillway Design SHEET 62 OF




Water hits the block similar to a jet against a stationary flat plate.

C.E. Hnbk Urquhart 4th Ed Pg 4-102

At dc

$$\frac{q^3}{T} = \frac{Q^3}{g}$$

Hnbk of Hydraulics King 4th Ed. Pg. 8-25

$a_1 = 15(4.0)(5) = 300\ ft^2$

$a_2 = 150(d_T - 4.0) = 150d_T - 600.0$

$a_T = 150d_T - 300$

N.E.H. Sec. 5 Pg. 5.4-13

$$\frac{(150d_T - 300)^3}{150} = \frac{(16000)^2}{32.2}$$

$$150d_T - 300 = \left[\frac{150(16000)^2}{32.2}\right]^{1/3} = 1059.715$$

$$d_T = \frac{1059.715 + 300}{150} = 9.06$$

Assume no hydrostatic force on down-stream side of blocks

Take a Unit Section

$A = 150(4.0) = 600\ ft^2$

$V_c = \frac{16000}{600} = 26.667$ fps.

$q_{max}$ against block $= V_c = 26.667(4.0) = 106.667$ cfs

COMPUTATION SHEET

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| STATE | PROJECT | |
|---|---|---|
| Arizona | Harquahala Valley WP | |
| BY W.E. Payne | DATE 5-13-80 | CHECKED BY | DATE | JOB NO. FRS |

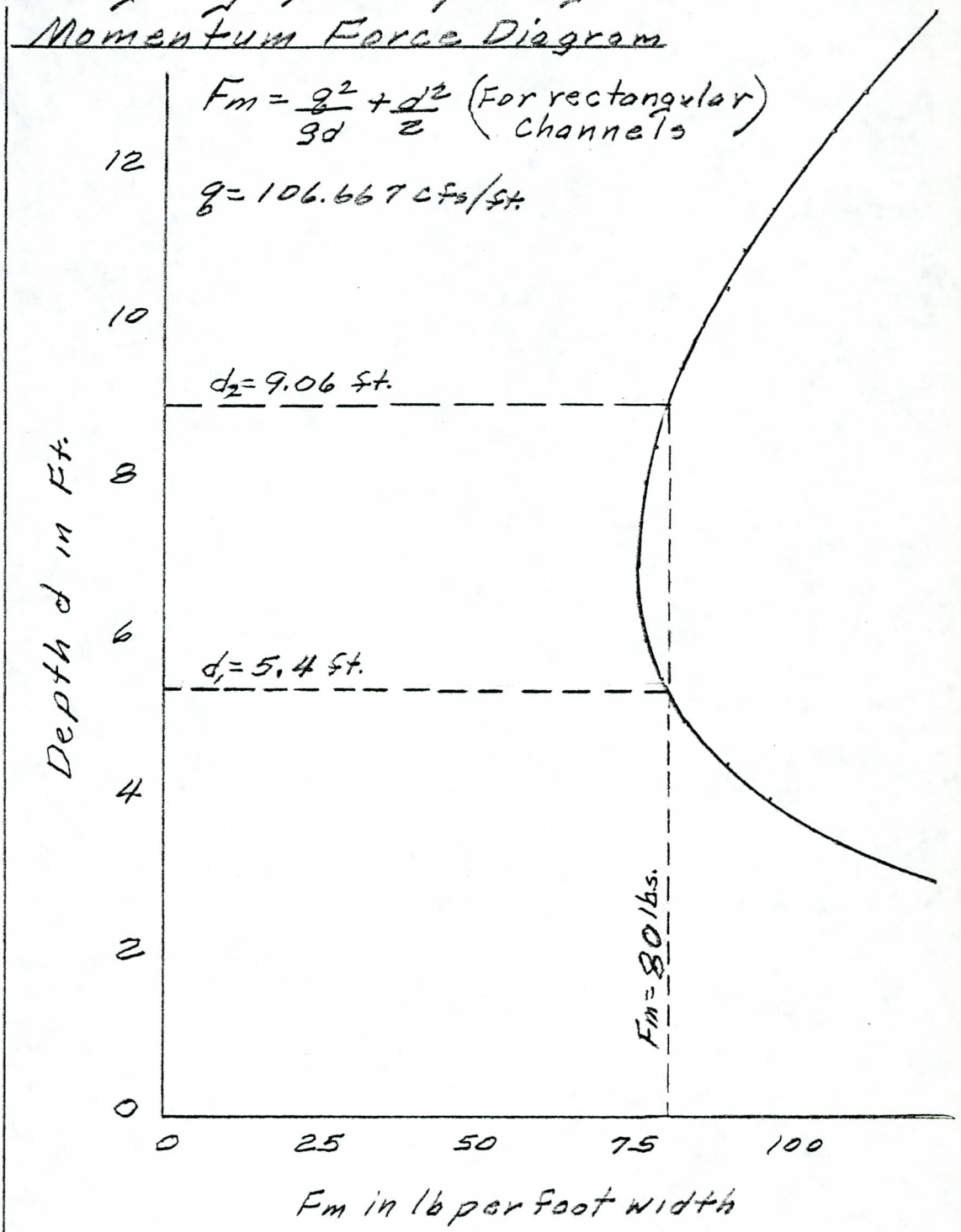
SUBJECT Emergency Spillway Design SHEET 63 OF

## Momentum Force Diagram

$F_m = \frac{q^2}{gd} + \frac{d^2}{2}$ (For rectangular channels)

$q = 106.667$ cfs/ft.

| d | Fm |
|---|---|
| 3 | 122.3 |
| 4 | 96.3 |
| 5 | 83.2 |
| 6 | 76.9 |
| 7 | 75.0 |
| 8 | 76.2 |
| 9 | 79.8 |
| 10 | 85.3 |
| 11 | 92.6 |
| 12 | 101.4 |



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|---|---|---|---|---|
| Arizona | | Harquahala Valley WP | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. |
| W.E Payne | 5-13-80 | | | ERS |
| SUBJECT | | | | SHEET 64 OF |
| Emergency Spillway Design | | | | |

$$\Sigma M_{x_1} = (80)\left(\frac{4.0}{2}\right) + (62.4)(1.4)\left(\frac{4.0}{2}\right)^2 + (62.4)\left(\frac{4.0}{6}\right)^3 =$$

$$160 + 698.88 + 665.6 = 1524.48 \text{ Ft-lb.}$$

$$\Sigma M_{x_2} = (80)\left(\frac{4.0}{2}\right) + (62.4)(5.06)\left(\frac{4.0}{2}\right)^2 + (62.4)\left(\frac{4.0}{6}\right)^3 =$$

$$160 + 2525.952 + 665.6 = 3351.552 \text{ Ft-lb.}$$

Find Moment due to weight

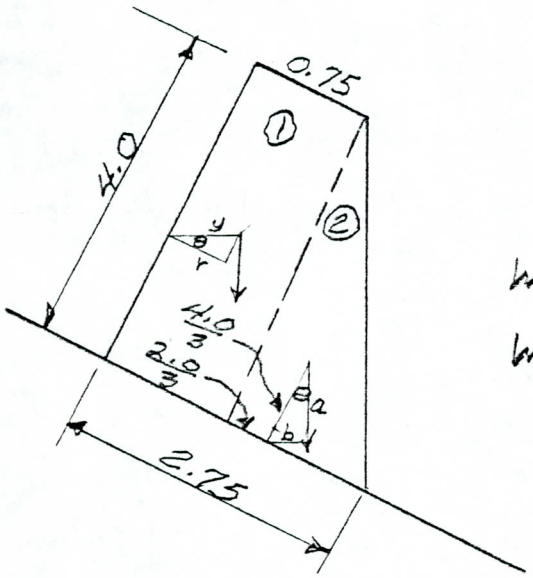
$\theta = 26.5667°$

$$r = \frac{\frac{0.75}{2}}{\cos\theta} = 0.419$$

$$y = \frac{4.0}{2}\sin\theta = 0.894$$

$$a = \left(0.75 + \frac{2.0}{3}\right)\cos\theta = 1.267$$

$$b = \frac{4.0}{3}\sin\theta = 0.596$$




$W_1 = (0.75)(4.0)(150) = 450.0$

$W_2 = (2.0)(4.0)(150)(0.5) = 600.0$

$M_T = \Sigma M_x + \Sigma M_w$

$M_1 = (r+y)W_1 = (0.419 + 0.894)450.0 = 590.85$ Ft-lb.

$M_2 = (a+b)W_2 = (1.267 + 0.596)600.0 = 1117.8$ Ft-lb.

$\Sigma M_w = 590.85 + 1117.8 = 1708.65$ Ft-lb.

Use $M_{x_2}$

$M_T = 3351.552 + 1708.65 = 5060.202$ Ft-lb.

COMPUTATION SHEET

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SOIL CONSERVATION SERVICE



| STATE Arizona | | PROJECT Harquahala Valley WP | | |
|---|---|---|---|---|
| BY W.E.Payne | DATE 5-13-80 | CHECKED BY [illegible] | DATE 6-80 | JOB NO FRS |

SUBJECT Emergency Spillway Design SHEET 65 OF

From ES-164

$M = 5.06$ Ft-K @ $d = 30$ in. $A_s$ required $= 0.11$ in$^2$

Temperature steel requires #6 @ 12 $A_s = 0.44$ in$^2$

Check shear

$W = (0.75 + \frac{2.0}{2})(4.0)(150) = 1050.0$ lb.

$V = \Sigma F_x + W = 80 + 1050.0 = 1130.0$ lb.

$v = \frac{V}{bd}$ $d = 30.5$"

$v = \frac{1130.0}{(12)(30.5)} = 3.087$ psi $<$ 70 psi O.K.

$Zo = \frac{8V}{7du} = \frac{8(1130.0)}{7(30.5)(350)} = 0.121$ in. $<$ 2.36 in. #6 @ 12

COMPUTATION SHEET

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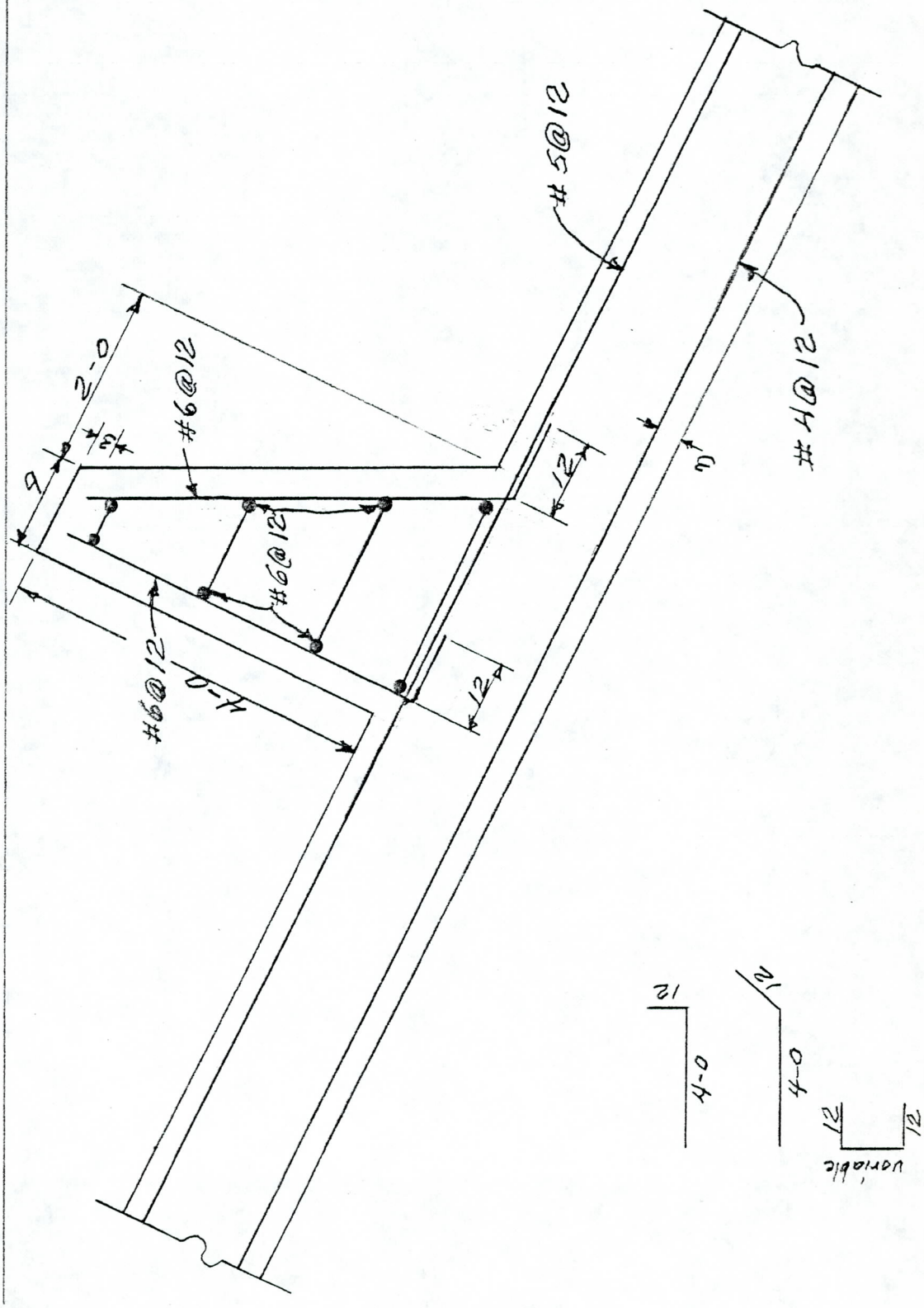
| STATE | | PROJECT | | |
|---|---|---|---|---|
| Arizona | | Harquahala Valley WP | | |
| BY | DATE | CHECKED BY | DATE | JOB NO |
| W.E. Payne | 5-13-80 | [illegible] | 6-80 | F.R.S. |
| SUBJECT | | | | SHEET 66 OF |
| Emergency Spillway Design | | | | |

Block Steel Sketch



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| STATE | | PROJECT | | |
|---|---|---|---|---|
| Arizona | | Harquahala Valley WP | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. |
| W.E. Payne | 6-18-80 | | | EAS |

SUBJECT Emergency Spillway Design — SHEET 67 OF

## Drain Fill

The drain fill shall be designed in accordance with Soil Mechanics Note 1. Three samples from TP-86 (Station 382+00) of GM material and one sample from DH-59 (Station 103+00) of GM material were considered to be representative of the base material found at the emergency spillway (Station 939+20) and would be used as fill for the embankment. A drain filter was plotted for each of the samples. A comparison was made with ASTM coarse aggregate sizes. ASTM Size 357 appears to satisfy all the requirements of SM Note 1 for the base material.

The drain shall extend from the end of the headwall extension, below the footing, to the entrance sidewall, make a 90° turn along the sidewall and connect with the transverse drain above the Fujimoto entrance. The drain then extends along the chute sidewall footing and connects to the transverse drain at the rockline. The drain continues along

| STATE | | PROJECT | | |
|---|---|---|---|---|
| Arizona | | Harquahala Valley W.P. | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. |
| W.E. Payne | 6-19-80 | | | E.R.S. |
| SUBJECT | | | | SHEET 68 OF |
| Emergency Spillway Design | | | | |

the chute sidewall footing and outlets through the wingwall at the bottom of the chute. The drain will be the same on both sides of the chute.

Filter Required

| Size | % Passing |
|---|---|
| 3" | 100 |
| 2" | 66-100 |
| 1" | 39-65 |
| ½" | 19-40 |
| 3/8" | 12-31 |
| #4 | 0-11 |

ASTM 35T

| Size | % Passing |
|---|---|
| 2½" | 100 |
| 2" | 95-100 |
| 1" | 35-70 |
| ½" | 10-30 |
| #4 | 0-5 |

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FILE CODE ENG-22

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| MATERIALS TESTING REPORT | U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE | SOIL CLASSIFICATION |
|---|---|---|

PROJECT and STATE: HARQUAHALA VALLEY ARIZONA

SAMPLE LOCATION: CAP 832+00

FIELD SAMPLE NO.: TP-86

DEPTH: 0-3.9'

GEOLOGIC ORIGIN: UPPER ALLUVIAL FAN

TYPE OF SAMPLE: DISTURBED

TESTED AT: SH&B

APPROVED BY:

DATE:

SYMBOL: GM

DESCRIPTION: SANDY SILTY GRAVEL

GRAIN SIZE DISTRIBUTION

| $D_{10}$ | $D_{15}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{85}$ | $D_{MAX}$ | $C_u$ | $C_c$ |
|---|---|---|---|---|---|---|---|---|
| | | | 1.5 | 4.0 | 17 | 76.1 | | |

COBBLES | GRAVELS | SANDS | FINES

SIEVE OPENING, (mm)

U.S. STANDARD SIEVE SIZE

| 3" | 2" | 1" | ½" | ⅜" | #4 | #10 | #20 | #40 | #60 | #100 | #140 | #200 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100 | 66-100 | 39-65 | 19-40 | 12-31 | 0-11 | | | | | | | |

BASE?

GRAIN SIZE IN MILLIMETERS

PERCENT FINER BY DRY WEIGHT

UNDISTURBED CONDITION

| MOISTURE | DRY UNIT WEIGHT |
|---|---|
| 2.8 % | pcf / g/cc |

| SOLUBLE SALTS | SHRINKAGE LIMIT |
|---|---|
| % | % |

ATTERBERG LIMITS

| | NATURAL MOISTURE | | AIR DRY | | OVEN DRY | |
|---|---|---|---|---|---|---|
| | LL | PI | LL | PI | LL | PI |
| | | | | | 33 | 8 |

SPECIFIC GRAVITY ($G_s$)

| (-) #4 | (+) #4 |
|---|---|
| | |

REMARKS:

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| MATERIALS TESTING REPORT | U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE | SOIL CLASSIFICATION |
|---|---|---|

PROJECT and STATE: HARQUAHALA VALLEY ARIZONA
SAMPLE LOCATION: CAP 882+00
FIELD SAMPLE NO.: TP-86
DEPTH: 6-9'
GEOLOGIC ORIGIN: UPPER ALLUVIAL FAN
TYPE OF SAMPLE: DISTURBED
TESTED AT: SH&B
APPROVED BY:
DATE:
SYMBOL: GM
DESCRIPTION: SILTY SANDY GRAVEL

GRAIN SIZE DISTRIBUTION

| $D_{90}$ | $D_{15}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{85}$ | $D_{MAX}$ | $C_u$ | $C_c$ |
|---|---|---|---|---|---|---|---|---|
| | | 1.5 | 6.35 | 10.0 | 55 | 101.6 | | |

COBBLES | GRAVELS | SANDS | FINES

SIEVE OPENING, (mm) | U.S. STANDARD SIEVE SIZE

PERCENT FINER BY DRY WEIGHT

GRAIN SIZE IN MILLIMETERS

BASED

UNDISTURBED CONDITION

| MOISTURE | DRY UNIT WEIGHT g/cc | pcf |
|---|---|---|
| 2.0 % | | |

| SOLUBLE SALTS | SHRINKAGE LIMIT |
|---|---|
| % | % |

ATTERBERG LIMITS

| NATURAL MOISTURE LL | NATURAL MOISTURE PI | AIR DRY LL | AIR DRY PI | OVEN DRY LL | OVEN DRY PI |
|---|---|---|---|---|---|
| | | | | 31 | 5 |

SPECIFIC GRAVITY ($G_s$)

| (-) #4 | (+) #4 |
|---|---|
| | |

REMARKS:

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| MATERIALS TESTING REPORT | U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE | SOIL CLASSIFICATION |
|---|---|---|

PROJECT and STATE: HARQUAHALA VALLEY ARIZONA
SAMPLE LOCATION: CAP 882+00
FIELD SAMPLE NO.: TP-86
DEPTH: 12'-15'
GEOLOGIC ORIGIN: UPPER ALLUVIAL FAN
TYPE OF SAMPLE: DISTURBED
TESTED AT: SHSB
APPROVED BY:
DATE:
SYMBOL: GM
DESCRIPTION: SILTY SANDY GRAVEL

GRAIN SIZE DISTRIBUTION

$D_{MAX}$ 50.8
$D_{85}$ 14.5
$D_{60}$ 4.9
$D_{30}$ 0.36
$D_{15}$
$D_{10}$
$C_u$ 2.8
$C_c$

GRAVELS | SANDS | FINES
COBBLES

SIEVE OPENING, (mm)
U.S. STANDARD SIEVE SIZE

GRAIN SIZE IN MILLIMETERS

PERCENT FINER BY DRY WEIGHT

BASED

UNDISTURBED CONDITION
MOISTURE 5.3 %
DRY UNIT WEIGHT 9.14 g/cc pcf

SHRINKAGE LIMIT %
SOLUBLE SALTS %

ATTERBERG LIMITS
NATURAL MOISTURE: LL, PI
AIR DRY: LL, PI
OVEN DRY: LL, PI

SPECIFIC GRAVITY ($G_s$)
(+) #4
(-) #4

REMARKS:

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| MATERIALS TESTING REPORT | U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE | SOIL CLASSIFICATION |
|---|---|---|

PROJECT and STATE: HARQUAHALA VALLEY ARIZONA — SAMPLE LOCATION: CAP 103+00

FIELD SAMPLE NO.: DH-59 — DEPTH: 8'-33' — GEOLOGIC ORIGIN: UPPER ALLUVIAL FAN

TYPE OF SAMPLE: DISTURBED — TESTED AT: SH&B — APPROVED BY — DATE

SYMBOL: GM — DESCRIPTION: SILTY SANDY GRAVEL

GRAIN SIZE DISTRIBUTION

| $D_{90}$ | $D_{15}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{85}$ | $D_{MAX}$ | $C_u$ | $C_c$ |
|---|---|---|---|---|---|---|---|---|
| | 0.105 | 1.3 | 4.5 | 6.5 | 13 | 38.1 | | |

COBBLES | GRAVELS | SANDS | FINES

SIEVE OPENING, (mm)

U.S. STANDARD SIEVE SIZE

GRAIN SIZE IN MILLIMETERS

PERCENT FINER BY DRY WEIGHT

BASE

UNDISTURBED CONDITION

| MOISTURE % | DRY UNIT WEIGHT g/cc | pcf |
|---|---|---|
| | | |

SOLUBLE SALTS %

SHRINKAGE LIMIT %

ATTERBERG LIMITS

| | NATURAL MOISTURE LL | NATURAL MOISTURE PI | AIR DRY LL | AIR DRY PI | OVEN DRY LL | OVEN DRY PI |
|---|---|---|---|---|---|---|
| | | | | | | NP |

SPECIFIC GRAVITY ($G_s$)

| (-) #4 | (+) #4 |
|---|---|
| | |

REMARKS:

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| MATERIALS TESTING REPORT | U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE | SOIL CLASSIFICATION |
|---|---|---|

PROJECT and STATE: HARQUAHALA VALLEY ARIZONA

SAMPLE LOCATION: CAP 882+00

FIELD SAMPLE NO.: TP-86

DEPTH: 0-3.9'

GEOLOGIC ORIGIN: UPPER ALLUVIAL FAN

TYPE OF SAMPLE: DISTURBED

TESTED AT: SH&B

APPROVED BY:

DATE:

SYMBOL: GM

DESCRIPTION: SANDY SILTY GRAVEL

GRAIN SIZE DISTRIBUTION

| $D_{10}$ | $D_{15}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{85}$ | $D_{MAX}$ | $C_u$ | $C_c$ |
|---|---|---|---|---|---|---|---|---|
| | | | 1.5 | 4.0 | 17 | 76.1 | | |

GRAVELS | SANDS | FINES | COBBLES

U.S. STANDARD SIEVE SIZE: 3" 2" 1" ¾" ⅜" #4 #10 #20 #40 #60 #100 #140 #200

SIEVE OPENING, (mm): (304.4) (152.2) (76.1) (50.8) (38.1) (25.4) (19.0) (12.7) (9.51) (4.76) (2.00) (1.19) (0.84) (0.59) (0.42) (0.297) (0.250) (0.149) (0.105) (0.074)

Fine Low Med High

GRAIN SIZE IN MILLIMETERS

PERCENT FINER BY DRY WEIGHT

100 90 80 70 60 50 40 30 20 10 0

3" 2" 1" ¾" ⅜" #4

100 66-100 39-68 19-40 12-31 0-11

BASED

UNDISTURBED CONDITION

| MOISTURE | DRY UNIT WEIGHT |
|---|---|
| 2.8 % | g/cc / pcf |

| SOLUBLE SALTS | SHRINKAGE LIMIT |
|---|---|
| % | % |

ATTERBERG LIMITS

| | NATURAL MOISTURE | | AIR DRY | | OVEN DRY | |
|---|---|---|---|---|---|---|
| | LL | PI | LL | PI | LL | PI |
| | | | | | 33 | 8 |

SPECIFIC GRAVITY ($G_s$)

| (-) #4 | (+) #4 |
|---|---|
| | |

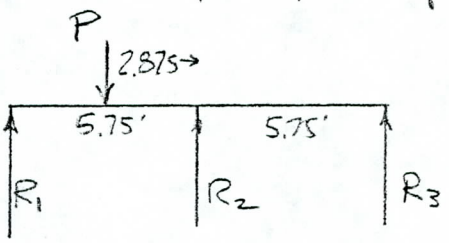
REMARKS:

PRINCIPAL SPILLWAY
STRUCTURAL DESIGN

AZ Harquahala Valley WPP- HARQ.FRS

SML 1-21-80 R.A.P. 1-23-80

Trashrack - Principal Spillway Top 1 2




$M_{max} = \frac{13}{64} Pl$

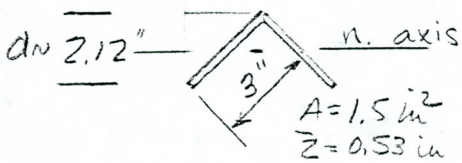
assume worst load situation 300# man @ center on one bar.

Velocities through trashrack highest at peak hydrograph discharge (<2.5 fps), when any floating debree would be above riser. Impact at this velocity would not be great.

$P = 300\#$ $l = 5.75$ ft.

$M_{max} = \frac{13}{64}(300)(5.75) = 350.4$ ft# or 0.35 ft-K

Check 3" x 3" x ¼" ∠




$c = \frac{d}{2} = \frac{.707(3")}{2} = 1.06"$

$I = 0.56 in^4$

$S = \frac{I}{c} = \frac{0.56 in^4}{1.06 in} = 0.53 in^3$

$S_{req} = \frac{M}{F_b} = \frac{(350.4)(12)}{22,000} = 0.19 in^3 < 0.53 in^2$

equiv.

0.7075

2.12

$I = \frac{bd^3}{12}$

$= \frac{(.7075)(2.12)^3}{12}$

$= 0.562$

$F_b = 0.6 F_y$

$= 22$ ksi.

$F_v = 14.5$ ksi

Check shear.

$V = F_v A = (14,500)(1.5) = 21,750\#$ allow.

$V_{max} = P = 300\# < 21,750\#$ OK.

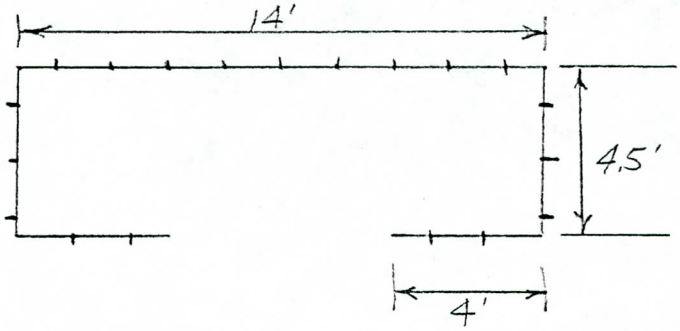
Use 3" x 3" x ¼" ∠s

AZ Harquahala Valley WPP-HARQ.FRS

SMC 1-21-80 R.A.P. 1-28-80

Trashrack - Principal Spillway 2 2

say 4¼" / channel,




want $V_{max} = 2$ fps, $Q_{max} = 390$ cfs

$A_{min} = Q/V = \frac{390}{2} = 195$ ft²

$A_{total} = 2(5.75)[4 + 4.5 + 14 + 4.5 + 4]$

$= 356.5$ ft²

$A_{avail.\ for\ bars} = 356.5 - 195 = 161.5$ ft² max

Select spacing 18" c-c, clear opening = 13.76"

(much < ½ D)

(9 + 6 + 4) bars (4.24" ÷ 12)(5.75 ft) = 33.60 ft²

$V = 390 \div (356.5 - 33.60) = 1.23$ fps. good.

AZ — Harquahala Valley WPP - HARQ.FRS

SML 1-18-80 R.A.P. 1-28-80

check riser bouyancy 1 1

approx. displacement volume

$(12+2.5)(4+2.5)(20.42)+1.5(16.5)(10.5)=2184.5\ ft^3$

equiv. wt. of water

$(62.4)(2184.5)=136,313\ \#$

---

approx. wt. of riser

$(47.4\ c.y.)(150\ \#/ft^3)(27\ ft^3/c.y.)=191,970\ \#$

Soil above riser footings.

$8'[(2\times16.5\times2)+(2\times4)]=592\ ft^3$

$\sim 73\ \#/ft^3\ \gamma_b$

$(592)(73)=43,216\ \#$

---

Safety factor against floating

$$\frac{191,970+43,216}{136,313}=1.725 \leftarrow$$

$>1.5$

~~AZ~~. Harquahala Valley WPP – HARQ.FRS

SWL 1-17-80 R.L.P. 1-21-80

Prime. Spwy. Conduit Loads – 48-inch 1 4

Check upstream side of dam, fully saturated soil to emergency hydrograph crest, el. 1412.8.

Invert el. 1362.8, diff. = 50.0 ft. (sat. soil)

SP-5 Lock Joint nom.- 16'L

assume $t = 3\frac{7}{8}$", $b_c = [48 + 2(3\frac{7}{8})] \div 12 = 4.646$ ft.

assume cradle, $b = 6.17$ ft.

non-yielding foundation (GM), ES-5148-CE

TR-5 proced. pg. 3-37

is permeable

(TR-5, 3-42, $C_c$ is for soils with clay)

assume $\delta = 1$, $p b_c = \frac{b_c}{2} + 3.42 = 5.74$ ft.

$K_\mu \sim 0.19$, $2K_\mu = 0.38$ $\rho = \frac{p b_c}{b_c} = \frac{5.74}{4.646} = 1.24$

$H_c = 50 - [(5.74 - 4.64) + 4.64] = 44.26$ ft.

$2K_\mu \frac{H_c}{b_c} = (0.38)\frac{44.26}{4.646} = 3.62$

$2K_\mu \delta_p = (0.38)(1)(1.24) = 0.47$

positive projecting condition by constr. meth.

ES-117, complete condition? No, Incompl.

$\delta_p = 1.24$, $\frac{H_e}{b_c} = 2.2 < \frac{H_c}{b_c} = \frac{44.26}{4.65} = 9.52$

$C_p$, ES-118 $2K_\mu C_p = 7.70$ $C_p = 20.26$

$X_p$, ES-120 0.400

$T$, ES-121 5.71

$S = 1$, R/C pipe $F_{sr} = C_p X_p - KT$

$[\phi = 25°]$ $F_{sr} = (20.26)(0.4) - (0.4)(5.71) = 5.82 = F_{sp}$

$\gamma_s = 136\ \#/ft^3$ $R_{eb} = \frac{(\gamma_s F_{sp})\, b_c^2}{1.431} = \frac{(136)(5.82)(4.646)^2}{1.431} = 11{,}939.3\ \#/ft.$

AZ Harquahala Valley WPP – HARQ, FRS

SWL 1-17-80 R.A.P. 1-21-80

Princ. Spwy. Conduit 48-Inch D 2 4

TR5, Pg. 2-7, ignore hydrostatic load

Pg. 2-6, internal pressures

adjust $R_{eb}$ req'd. by dividing by 95%. to allow for internal pressures of 50ft± head.

Based on assumed $A_s = 4.34\ in^2$ (circumferential) 48-inch dia., $f_s = 20{,}000$ psi & $p_i = \frac{50}{2.31} = 21.65$ psi.

$$N = \frac{A_s f_s}{6D} = \frac{(4.34)(20{,}000)}{(6)(48)} = 301.39 \text{ psi.}$$

$$R'_{eb} = R_{eb}\sqrt{\frac{N - p_i}{N}}$$ reduced pipe str., existing pipe

$$= R_{eb}\sqrt{\frac{301 - 22}{301}} = 0.96\, R_{eb}$$

$$R_{eb}\ \text{req'd.} = \frac{R'_{eb}}{.96}$$ pipe str. / red. factor

Do not know actual steel area, so use 95%.

$R_{eb} = \frac{11{,}939.3}{.95} = 12{,}568$ #/ft, use 12,600 #/ft²

---

Check ds, top of dam, dry, $\gamma = 130$ #/ft³

El. 1419.7 − El. 1362.28 = 57.42 ft. invert.

$57.42 - (b_c - t) = 53.10$ ft. $= H_c$

$\delta = 1$ $\rho b_c = 5.74$ $\rho = 1.24$ (no change)

$K_\mu \cong 0.19$ $2K_\mu = 0.38$ $K_N$ 0.4 @ $\phi = 25°$

$2K_\mu H_c \div b_c = 0.38\left(\frac{53.1}{4.65}\right) = 4.34$

$2K_\mu \delta_p = (0.38)(1.24) = 0.47$ $\delta_p = 1.24$

AZ Harquahala Valley WPP- HARQ.FRS

SML 1-17-80 R.A.P. 1-21-80

Princ. Spury. Conduit Loads 3 4

.01, 3 edge bearing

ES-117

$\frac{H_c}{b_c} = \frac{53.1}{4.65} = 11.42 > \frac{H_c}{b_c} = 2.2$

incomplete condition

$2K_\mu C_p = 9.35 \qquad C_p = \frac{9.35}{1.38} = 24.61$

$X_p = 0.400$

$T = 7.60$

$F_{sr} = C_p X_p - KT = (24.61)(0.4) - (0.4)(7.6) = 6.80$

if $s = 1$, $F_{sr} = F_{sp}$

$R_{eb} = \frac{\gamma F_{sp} b_c^2}{1.431} = \frac{(130)(6.8)(4.65)^2}{1.431} = 13,357.3$ #/ft.

adj. for internal water pressure

$R_{eb} = \frac{13,357.3}{0.95} = 14,060.3$ use 14,000 #/ft

---

Check under CAP, edge south bank

head above invert ~ 33 ft.

$33 - (4.65 - 0.32) = 28.67$ ft. $= H_c$

$\frac{H_c}{b_c} = \frac{28.67}{4.65} = 6.17$ (incomplete, >2.2)

$2K_\mu \frac{H_c}{b_c} = 0.38(6.17) = 2.34$

$2K_\mu F_{sp} = 1.24$ (same) $K \sim 0.4$

ES-117

$2K_\mu C_p = 4.71 \qquad C_p = 12.39$

$X_p = 0.4$

$T = 4.28$

AZ — Harquahala Valley WPP- HARQ. FRS

SML 1-17-80 R.A.P. 1-23-80

Princ. Spwy. Conduit Loads 4 4

385' $F_{sr} = C_p X_p - KT = (12.39)(0.4) - (0.4)(4.28) = 3.24$

$$R_{eb} = \frac{\gamma F_{sp} b_c^2}{1.431} = \frac{(130)(3.24)(4.65)^2}{1.431} = 6364.36 \text{ \#/ft.}$$

check internal pressure factor

$[1412.8 \text{ (hydrog.)} - 1354.3 \text{ (invert)}] .433 = 25.33$ psi

$N \sim 301$ psi. $\sqrt{\frac{N - p_i}{N}} = \sqrt{\frac{301 - 25.33}{301}} = 0.957$

OK, based on assumptions, use 95%

$R_{eb} = \frac{6365}{.95} = \underline{6700 \text{ \#/ft}}$

---

Call for required 3-edge bearing strength of 14,000 #/ft.

SP-5 or steel cylinder prestressed pipe.

RECTANGULAR STRUCTURAL CHANNEL
CROSS SECTION DESIGN
ELASTIC ANALYSIS AND WORKING STRESS DESIGN ARE USED

SPECIAL DESIGN PREPARED BY THE DESIGN UNIT AT GLENN DALE, MD.
FOR

HARQUAHALA FRS
PRINCIPAL SPILLWAY TANSITION

DESIGN PARAMETERS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| B= | 4.00 | HW1= | 0.0 | KO1= | 0.73 | FLOATR= | 1.50 | MFOUND= | 60000 |
| HT= | 5.00 | HW2= | 0.0 | KO2= | 0.35 | JOINTS= | 30.00 | GMOIST= | 13 |
| HB= | 5.00 | HWP= | 0.0 | KPASS= | 2.00 | MAXFTG= | 2.00 | GSAT= | 13 |
| | | | | CFSC= | 0.35 | CFSS= | ****** | | |

DESIGN OF SPECIFIED TYPE FOLLOWS

TYPE T1F STRUCTURAL CHANNEL - TRIAL VALUES

| | | | | | |
|---|---|---|---|---|---|
| TT= 10.00 | TB= 10.00 | TS= 11.00 | FTG PROJ= 0.0 | QUANT= | 0.501 |

TYPE T1F STRUCTURAL CHANNEL - DETAIL DESIGN

| | | | | | |
|---|---|---|---|---|---|
| TT= 10.00 | TB= 10.00 | TS= 11.00 | FTG PROJ= 0.0 | QUANT= | 0.501 |

STEEL REQUIREMENTS

WALL

| | | | |
|---|---|---|---|
| A( 1)= | 0.24 | S( 1)= | 18.00 |
| A( 2)= | 0.24 | S( 2)= | 18.00 |
| A( 3)= | 0.24 | S( 3)= | 18.00 |
| A( 4)= | 0.12 | S( 4)= | 18.00 |
| A( 5)= | 0.24 | S( 5)= | 18.00 |
| A( 6)= | 0.12 | S( 6)= | 18.00 |
| A( 7)= | 0.24 | S( 7)= | 18.00 |
| A( 8)= | 0.12 | S( 8)= | 18.00 |
| A( 9)= | 0.24 | S( 9)= | 18.00 |
| A(10)= | 0.15 | S(10)= | 18.00 |

BASE

A(11) - A(16) DO NOT EXIST SINCE FTG=0

| | | | |
|---|---|---|---|
| A(17)= | 0.26 | S(17)= | 18.00 |
| A(18)= | 0.13 | S(18)= | 18.00 |
| A(19)= | 0.26 | S(19)= | 18.00 |
| A(20)= | 0.13 | S(20)= | 18.00 |
| A(21)= | 0.26 | S(21)= | 18.00 |
| A(22)= | 0.13 | S(22)= | 18.00 |

END OF DESIGN

RECTANGULAR STRUCTURAL CHANNEL
CROSS SECTION DESIGN
ELASTIC ANALYSIS AND WORKING STRESS DESIGN ARE USED

15'

SPECIAL DESIGN PREPARED BY THE DESIGN UNIT AT GLENN DALE, MD.
FOR

HARQUAHALA FRS
PRINCIPAL SPILLWAY TRANSITION

DESIGN PARAMETERS

| | | | | | |
|---|---|---|---|---|---|
| B= 6.67 | HW1= 0.0 | KO1= 0.73 | FLOATR= 1.50 | MFOUND= 60000 | |
| HT= 4.00 | HW2= 0.0 | KO2= 0.35 | JOINTS= 30.00 | GMOIST= 13 | |
| HB= 4.00 | HWP= 0.0 | KPASS= 2.00 | MAXFTG= 2.00 | GSAT= 13 | |
| | | CFSC= 0.35 | CFSS= 0.55 | | |

DESIGN OF SPECIFIED TYPE FOLLOWS

TYPE T1F STRUCTURAL CHANNEL - TRIAL VALUES

TT= 10.00 TB= 10.00 TS= 11.00 FTG PROJ= 0.0 QUANT= 0.530

TYPE T1F STRUCTURAL CHANNEL - DETAIL DESIGN

TT= 10.00 TB= 10.00 TS= 11.00 FTG PROJ= 0.0 QUANT= 0.530

STEEL REQUIREMENTS

WALL

| | | | |
|---|---|---|---|
| A( 1)= | 0.24 | S( 1)= | 18.00 |
| A( 2)= | 0.24 | S( 2)= | 18.00 |
| A( 3)= | 0.24 | S( 3)= | 18.00 |
| A( 4)= | 0.12 | S( 4)= | 18.00 |
| A( 5)= | 0.24 | S( 5)= | 18.00 |
| A( 6)= | 0.12 | S( 6)= | 18.00 |
| A( 7)= | 0.24 | S( 7)= | 18.00 |
| A( 8)= | 0.12 | S( 8)= | 18.00 |
| A( 9)= | 0.24 | S( 9)= | 18.00 |
| A(10)= | 0.12 | S(10)= | 18.00 |

BASE

A(11) - A(16) DO NOT EXIST SINCE FTG=0

| | | | |
|---|---|---|---|
| A(17)= | 0.26 | S(17)= | 18.00 |
| A(18)= | 0.13 | S(18)= | 18.00 |
| A(19)= | 0.26 | S(19)= | 18.00 |
| A(20)= | 0.13 | S(20)= | 18.00 |
| A(21)= | 0.26 | S(21)= | 18.00 |
| A(22)= | 0.13 | S(22)= | 18.00 |

========== END OF DESIGN ==========

RECTANGULAR STRUCTURAL CHANNEL
CROSS SECTION DESIGN
ELASTIC ANALYSIS AND WORKING STRESS DESIGN ARE USED

45' SPECIAL DESIGN PREPARED BY THE DESIGN UNIT AT GLENN DALE, MD.
FOR

HARQUAHALA FRS
PRINCIPAL SPILLWAY TRANSITION

DESIGN PARAMETERS

| | | | | | |
|---|---|---|---|---|---|
| B= 12.00 | HW1= 0.0 | KO1= 0.73 | FLOATR= 1.50 | MFOUND= 60000 | |
| HT= 4.00 | HW2= 0.0 | KO2= 0.35 | JOINTS= 30.00 | GMOIST= | 13 |
| HB= 4.00 | HWP= 0.0 | KPASS= 2.00 | MAXFTG= 2.00 | GSAT= | 13 |
| | | CFSC= 0.35 | CFSS= 0.55 | | |

DESIGN OF SPECIFIED TYPE FOLLOWS

TYPE T1F STRUCTURAL CHANNEL - TRIAL VALUES

| | | | | |
|---|---|---|---|---|
| TT= 10.00 | TB= 10.00 | TS= 11.00 | FTG PROJ= 0.0 | QUANT= 0.711 |

TYPE T1F STRUCTURAL CHANNEL - DETAIL DESIGN

| | | | | |
|---|---|---|---|---|
| TT= 10.00 | TB= 10.00 | TS= 11.00 | FTG PROJ= 0.0 | QUANT= 0.711 |

STEEL REQUIREMENTS

WALL

| | |
|---|---|
| A( 1)= 0.24 | S( 1)= 18.00 |
| A( 2)= 0.24 | S( 2)= 18.00 |
| A( 3)= 0.24 | S( 3)= 18.00 |
| A( 4)= 0.12 | S( 4)= 18.00 |
| A( 5)= 0.24 | S( 5)= 18.00 |
| A( 6)= 0.12 | S( 6)= 18.00 |
| A( 7)= 0.24 | S( 7)= 18.00 |
| A( 8)= 0.12 | S( 8)= 18.00 |
| A( 9)= 0.24 | S( 9)= 18.00 |
| A(10)= 0.12 | S(10)= 18.00 |

BASE

A(11) - A(16) DO NOT EXIST SINCE FTG=0

| | |
|---|---|
| A(17)= 0.26 | S(17)= 18.00 |
| A(18)= 0.13 | S(18)= 18.00 |
| A(19)= 0.26 | S(19)= 18.00 |
| A(20)= 0.13 | S(20)= 18.00 |
| A(21)= 0.26 | S(21)= 18.00 |
| A(22)= 0.13 | S(22)= 18.00 |

========== END T1F DESIGN ==========

ELASTIC ANALYSIS AND WORKING STRESS DESIGN ARE USED

SPECIAL DESIGN PREPARED BY THE DESIGN UNIT AT GLENN DALE, MD.
FOR

HARQUAHALA FRS
PRINCIPAL SPILLWAY SAF

DESIGN PARAMETERS

| | | | | | | |
|---|---|---|---|---|---|---|
| W = 12.00 | D1 = 1.14 | HTW1= 0.50 | HB = 0.0 | GM =130.0 | MAXFTG= 6. |
| J = 10.00 | V1 = 28.40 | HUP1= 1.75 | ZS = 3.00 | GS =136.0 | FLOATR= 1. |
| LB= 10.00 | FROUDE= 21.97 | HTW2= 7.00 | HTW= 3.00 | KO = 0.730 | SLIDER= 1. |
| N = 4.00 | D2 = 7.01 | HUP2= 6.90 | TTW=10.00 | BAT= 0.0 | CFSC = 0. |

PRELIMINARY DESIGNS FOLLOW

TYPE (A) STILLING BASIN - TRIAL VALUES QUANT= 43.

| | | | | |
|---|---|---|---|---|
| LTOP= 27.35 | LN= 1.26 | HN= 3.79 | HV= 5.00 | |
| LBOT= 28.62 | LS= 18.62 | HS= 6.21 | | |
| TT= 10.00 | TV= 10.00 | TBB= 0.0 | TBV= 10.00 | TB= 10.0 |

FTG= 4.50 TSUP= 11.00 TSBG= 17.00 TSDN= 11.00
ASSOCIATED WINGWALL QUANT= 8.

SAF(B)--FLOTATION CRIT. NOT SATISFIED FOR LC=2 DESIGN CANCELED

TYPE (C) STILLING BASIN - TRIAL VALUES QUANT= 52.

| | | | | |
|---|---|---|---|---|
| LTOT= 28.00 | LS= 18.00 | HS= 6.00 | HV= 5.00 | |
| X= 5.00 | XP= 2.00 | | | |
| | TPUP= 38.00 | TPBG= 92.00 | TPDN= 65.00 | |
| TT= 10.00 | TV= 10.00 | TBB= 0.0 | TBV= 10.00 | TB= 10.0 |

FTG= 4.25 TSUP= 11.00 TSBG= 18.00 TSDN= 12.00
ASSOCIATED WINGWALL QUANT= 8.

WINGWALL DESIGN - TRIAL VALUES

| | | | |
|---|---|---|---|
| TWW= 10.00 | TWF= 14.00 | BUP= 9.00 | BDN= 6.00 |

========== END PRELIMINARY DESIGNS ==========

===
END OF DATA

ELASTIC ANALYSIS AND WORKING STRESS DESIGN ARE USED

SPECIAL DESIGN PREPARED BY THE DESIGN UNIT AT GLENN DALE, MD.
FOR

HARQUAHALA FRS
PRINCIPAL SPILLWAY SAF

FINAL DESIGN, Pg. 1 of 2

DESIGN PARAMETERS

| | | | | | | |
|---|---|---|---|---|---|---|
| W = 12.00 | D1 = 1.14 | HTW1= 0.50 | HB = 0.0 | GM =130.0 | MAXFTG= 6.00 |
| J = 10.00 | V1 = 28.40 | HUP1= 1.75 | ZS = 3.00 | GS =136.0 | FLOATR= 1.50 |
| LB= 10.00 | FROUDE= 21.97 | HTW2= 7.00 | HTW= 3.00 | KO = 0.730 | SLIDER= 1.00 |
| N = 5.35 | D2 = 7.01 | HUP2= 6.90 | TTW=10.00 | BAT= 0.0 | CFSC = 0.35 |

DESIGN OF SPECIFIED TYPE SAF FOLLOWS

TYPE (A) STILLING BASIN - TRIAL VALUES QUANT= 38.93

| | | | | | |
|---|---|---|---|---|---|
| LTOP= 23.07 | LN= 1.69 | HN= 5.08 | HV= 5.08 | | |
| LBOT= 24.77 | LS= 14.77 | HS= 4.92 | | | |
| TT= 10.00 | TV= 10.00 | TBB= 0.0 | TBV= 10.00 | TB= 10.00 | |
| FTG= 4.75 | TSUP= 11.00 | TSBG= 17.00 | TSDN= 11.00 | | |

TYPE (A) STILLING BASIN - DETAIL DESIGN QUANT= 38.93

| | | | | |
|---|---|---|---|---|
| TT= 10.00 | TV= 10.00 | TBB= 0.0 | TBV= 10.00 | TB= 10.00 |
| FTG= 4.75 | TSUP= 11.00 | TSBG= 17.00 | TSDN= 11.00 | |

STEEL REQUIREMENTS

WALL

| | | | | | |
|---|---|---|---|---|---|
| A( 1)= 0.24 | S( 1)= 18.00 | A( 6)= 0.24 | S( 6)= 18.00 |
| A( 2)= 0.24 | S( 2)= 18.00 | A( 7)= 0.24 | S( 7)= 18.00 |
| A( 3)= 0.24 | S( 3)= 18.00 | A( 8)= 0.24 | S( 8)= 18.00 |
| A( 4)= 0.17 | S( 4)= 18.00 | A( 9)= 0.24 | S( 9)= 18.00 |
| A( 5)= 0.33 | S( 5)= 18.00 | A(10)= 0.33 | S(10)= 18.00 |
| | | A( 0)= 0.24 | S( 0)= 18.00 |

BASE

SECTION AT DOWNSTREAM END

| | | | | | |
|---|---|---|---|---|---|
| A(11)= 0.26 | S(11)= 18.00 | A(17)= 0.26 | S(17)= 18.00 |
| A(12)= 0.13 | S(12)= 18.00 | A(18)= 0.13 | S(18)= 18.00 |
| A(13)= 0.26 | S(13)= 18.00 | A(19)= 0.26 | S(19)= 18.00 |
| A(14)= 0.13 | S(14)= 18.00 | A(20)= 0.13 | S(20)= 18.00 |
| A(15)= 0.26 | S(15)= 18.00 | A(21)= 0.26 | S(21)= 18.00 |
| A(16)= 0.13 | S(16)= 18.00 | A(22)= 0.13 | S(22)= 18.00 |

SECTION AT BREAK-IN-GRADE

| | | | | | |
|---|---|---|---|---|---|
| A(23)= 0.20 | S(23)= 18.00 | A(29)= 0.41 | S(29)= 18.00 |
| A(24)= 0.20 | S(24)= 18.00 | A(30)= 0.20 | S(30)= 18.00 |
| A(25)= 0.20 | S(25)= 18.00 | A(31)= 0.41 | S(31)= 18.00 |
| A(26)= 0.20 | S(26)= 18.00 | A(32)= 0.20 | S(32)= 18.00 |
| A(27)= 0.20 | S(27)= 18.00 | A(33)= 0.41 | S(33)= 18.00 |
| A(28)= 0.20 | S(28)= 18.00 | A(34)= 0.20 | S(34)= 18.00 |

SECTION AT UPSTREAM END

| | | | | | |
|---|---|---|---|---|---|
| A(47)= 0.13 | S(47)= 18.00 | A(53)= 0.26 | S(53)= 18.00 |
| A(48)= 0.13 | S(48)= 18.00 | A(54)= 0.13 | S(54)= 18.00 |
| A(49)= 0.13 | S(49)= 18.00 | A(55)= 0.51 | S(55)= 18.00 |
| A(50)= 0.13 | S(50)= 18.00 | A(56)= 0.13 | S(56)= 18.00 |
| A(51)= 0.26 | S(51)= 18.00 | A(57)= 0.65 | S(57)= 18.00 |
| A(52)= 0.13 | S(52)= 18.00 | A(59)= 0.13 | S(58)= 18.00 |

# Principal Spillway — FINAL DESIGN, Pg. 2 of 2

```
  TWW= 10.00       TWF= 10.00       BUP=  8.50       BDN=  5.50

              WINGWALL DESIGN - DETAIL DESIGN                    QUANT=   8.22
  TWW= 10.00       TWF= 10.00       BUP=  8.50       BDN=  5.50
LEVEL=  7.07     WPROJ= 10.43     WWLB= 12.37     VWING= 11.14

              STEEL REQUIREMENTS
READY
LIST PDSIGN.DATA 71 140 NONUM COL(7:85)
 PDSIGN.DATA
AREA OF TIE=  0.05
SECTION AT ARTICULATION JOINT
A( 1)=  0.24      S( 1)= 18.00                A( 4)=  0.12      S( 4)= 18.00
A( 2)=  0.24      S( 2)= 18.00                A( 5)=  0.14      S( 5)= 18.00
A( 3)=  0.24      S( 3)= 18.00                A( 6)=  0.12      S( 6)= 18.00
SECTION AT UPPER THIRD POINT
A( 7)=  0.24      S( 7)= 18.00                A(10)=  0.12      S(10)= 18.00
A( 8)=  0.24      S( 8)= 18.00                A(11)=  0.12      S(11)= 18.00
A( 9)=  0.12      S( 9)= 18.00                A(12)=  0.12      S(12)= 18.00
SECTION AT LOWER THIRD POINT
A(13)=  0.24      S(13)= 18.00                A(16)=  0.12      S(16)= 18.00
A(14)=  0.24      S(14)= 18.00                A(17)=  0.12      S(17)= 18.00
A(15)=  0.12      S(15)= 18.00                A(18)=  0.12      S(18)= 18.00

========================  END DETAIL DESIGN  ========================
READY
```

WPROJ?

too long > 10'

AZ — Harquahala Valley WPP - HARQ:FRS

SMC 1-29-80 R.A.P. 2-4-80

Steel, cut off wall, SAF 1

See TR-54, Pg. 75

$V = (KP)(GM)(DIF)(TSDN/12 + DIF/2)$

assume $K_p = 2.0$ $\gamma_m = 130\#/ft^3$ TSDN = 11" or 0.92'

HTW = 4.92 ft. DIF = 4.0 ft.

$V = (2.0)(130)(4)(0.92+2) = 3,036.8$ #/ft.

min thickness for shear $TS = \frac{3036.8}{840.} + 2.5 = 6.12"$ < 10"

$M = (KP)(GM)(DIF)(TSDN/24 + DIF/3)(DIF)$

$= (2)(130)(4)(11/24 + 4/3)(4) = 7453.33$ ft#/ft.

min thickness for moment $TM = \sqrt{(.003683)(7453.3)} + 2.5$

$TM = 7.74"$ < 10"

$S = 10015 (TTW - 2.5) \div V \leq 18.$

$= 18.42$, use 18" max spacing.

$A_s \approx 0.0006 \left(\frac{M}{.88\ d_{eff}}\right) > 0.024 (10")$

$0.68 > 0.24$

try d = 9.5 $0.0006\left(\frac{7453.33}{.88 \cdot 9.5}\right) = 0.53$ in² Use 12" #6@9

try d = 11.5 $0.0006\left(\frac{7453.33}{.88 \cdot 11.5}\right) = 0.44$ #6@12

w/ 14" thickness

AZ
SMC

Harquahala Valley WPP- HARQ. FRS
5-12-80 R.A.P. 6-5-80
C/o collars, Principal Spillway 1 1

Under dam: GW-GM material, good drainage

Left = 235 ft.

Check @ 15% flow path increase

$1.15(235) = 270.25$

$\frac{270.25 - 235}{4.67 \text{ ft.}} = 7.55$ or 8 collars

(Vertical distance around collar is 2.0 + 2.0 + 0.67 = 4.67 ft., Horizontal distance is 8.67 ft.)

check at 20% flow path increase

$1.20(235) = 282$

$\frac{282 - 235}{4.67} = 10.06'$ or 10 collars

USE 10 collars @ 20 ft. cc

Under CAP d.s. fill

Left ~ 100 ft. ; 20% increase = 20' & 15% = 15

$\frac{20}{4.67} = 4.28$ collars $\frac{15}{4.67} = 3.21$ collars

USE 4 collars @ 20 ft. cc.

AZ
Suc 3-11-80 Harquahala Valley WPP - HARQ. FRS

est. permeability of soils @ 1 2
Principal Spillway outlet

Sample No 1. depth 12-15 ft. GW-GM

$D_{10}$ = 0.41 mm (0.041 cm.)

Compacted to 100% (D698) → 38 to 0.00082 fpd

natural state, Casagrande → 2.8 to 280 fpd.

natural state, $K = CD_{10}^2$, CN 90 → ~424 fpd.

---

Sample No 2. depth 20-22, GW

$D_{10}$ = 0.66 mm (0.066 cm)

Compacted to 100% (D698), → 38 to 110 fpd

natural state, Casagrande → 2.8 to 28,000 fpd

natural state, $K = CD_{10}^2$, CN 95 → 1159 fpd.

---

Sample No 3. depth 22-25 ft. GW

$D_{10}$ = 0.9 mm (0.09 cm)

Compacted to 100% (D698) → 38 to 110 fpd

natural state, Casagrande → 2.8 to 28,000 fpd.

natural state, $K = CD_{10}^2$, CN 95 → 2155 fpd.

---

Summary:

Compacted, use 40 to 0.001 fpd.

natural, use 100 to 2500 fpd.

Concurred in: Aubrey C Sanders Jr. 4/8/80

AZ. Harquahala Valley WPP- HARQ. FRS

SM 4-8-80

Comments

Z Z

Aubrey Sanders, State geologist, and I reviewed field permeability tests for Harquahala F.R.S. and the adjacent C.A.P. aqueduct. These tests produced permeability coeficients of 0.5 to 1.81 feet per day in a range of soils from SM through GP-GM. We have chosen to ignor these results, at least for the principal spillway location, for the following reasons:

1. Our samples have far less fine sand in them than any of the tested soils appear to have.
2. Aubrey is suspicious of tests that reach equilibrium conditions in 30 min. (Bulec test data).
3. The h values by Az. Water Com. are not average head, they are total depth of hole.
4. None of the field tests are at expected full reservoir heads. (pressure)

PRINCIPAL SPILLWAY
HYDRAULICS

AZ
SMC 1-15-80 R.A.P. 1-18-80

Harquahala Valley WPP-HARQ.FRS

Hydraulics, Final Design, Stage/Q 1 3

Open riser inlet to 48-inch R/C pipe

L = 460 ft., assume n = 0.013

Top of Dam El. 1419.7 ft.

15.59 ft. fall in pipe

Outlet elev. @ full pipe - 1355.7 ft.
(supported flow @ crown)

Crest Princ. Spwy. Riser El. 1367.3 ft.

Kings 5th Ed. Table 5-3

Weir Flow - $Q = C_L L H^{3/2}$ ($C_N$ 3.3)
$L = 22.33$ ft.

Full Pipe Flow @ 265 cfs (see sheet )

$$Q = CA\sqrt{2gh} \qquad C = \frac{1}{\sqrt{1 + K_e + L K_p}}$$

Design NH. #8

$K_e$ bet. 0.5 & 1.0

$K_p = 0.00493$

Std. open riser round conduit w/round bottom $K_e = 0.5$

$$C = \frac{1}{\sqrt{1 + 1 + 460(.00493)}} = 0.4841$$

$$Q = (0.4841)\ (12.57)\ (8.025)\ h^{1/2} = 48.83\ h^{1/2}$$

| Elev. | H | Q | comment |
|---|---|---|---|
| 1387.3 | 0 | 0 | crest prin. spwy. weir flow |
| 1388 | 0.7 | 43.16 | |
| 1389 | 1.7 | 163.33 | |
| 1389.65 | 2.35 | 265.5 | full pipe, approx. |
| 1390 | 34.3 | 285.98 | |
| 1391 | 35.3 | 290.12 | |
| 1392 | 36.3 | 294.20 | |
| 1393 | 37.3 | 298.22 | |
| 1394 | 38.3 | 302.19 | |

AZ
SMC

Harquahala Valley WPP- HARQ. FRS

1-15-80 R.A.P. 1-13-80

Stage/Discharge, Final 2 3

| Elev. | H | Q | comment |
|---|---|---|---|
| 1395 | 39.3 | 306.11 | |
| 1396 | 40.3 | 309.98 | |
| 1397 | 41.3 | 313.81 | |
| 1398 | 42.3 | 317.58 | |
| 1399 | 43.3 | 321.31 | |
| 1400 | 44.3 | 325.00 | |
| 1401 | 45.3 | 328.65 | |
| 1402 | 46.3 | 332.26 | |
| 1403 | 47.3 | 335.83 | |
| 1404 | 48.3 | 339.36 | |
| 1405 | 49.3 | 342.85 | |
| 1406 | 50.3 | 346.31 | |
| 1407 | 51.3 | 349.74 | |
| 1408 | 52.3 | 353.13 | |
| 1408.4 | 52.7 | 354.48 | crest em. spwy. |
| 1409 | 53.3 | 356.49 | |
| 1410 | 54.3 | 359.82 | |
| 1411 | 55.3 | 363.12 | |
| 1412 | 56.3 | 366.39 | |
| 1412.8 | 57.1 | 368.98 | Em. Spy. Hydrog. peak |
| 1413 | 57.3 | 369.63 | |
| 1414 | 58.3 | 372.84 | |
| 1415 | 59.3 | 376.02 | |

AZ
SML

Harquahala Valley WPP – HARQ. FRS

1-15-80 R.A.P. 1-18-80

Stage / Discharge 3 3

| Elev. | H | Q | comment |
|---|---|---|---|
| 1416 | 60.3 | 379.18 | |
| 1417 | 61.3 | 382.31 | |
| 1418 | 62.3 | 385.42 | |
| 1419 | 63.3 | 388.50 | |
| 1419.7 | 64.0 | 390.64 | top of dam |

check peak Q if $K_e = 0.5$

$$C = \frac{1}{\sqrt{1.5 + 460(0.00493)}} = 0.5152$$

$$Q = 0.5152\,(12.57)(8.025)(64.0)^{1/2} = 415.74 \text{ cfs.}$$

(for downstream channel)

$$V_{max} = \frac{390.64}{12.57} = 31.08 \text{ fps.}$$

use 390 cfs @ 31 fps

check emerg. spillway hydrograph peak w/ C = 0.5152

$$Q = (0.5152)(12.57)(8.025)(57.1)^{1/2} = 392.71 \text{ cfs.}$$

$$V = 392.71 / 12.57 = 31.24 \text{ fps}$$

use 390 cfs @ 31 fps.

Az. Harquahala Valley WPP – HARQ-FRS

Suc 12-6-79

check 48-inch prima spwy. for full pipe flow & negative pressures — free outflow. 1 2

See NEH-5 (5.5-8) eqn.

$S = 0.0339$ $\quad S_n = \dfrac{K_c \frac{V^2}{2g}}{\sqrt{1-\left(K_c \frac{V^2}{2g}\right)^2}}$ $\quad K_c = 0.00493$ for $n = 0.013$

Solve for V & then Q to determine full-flow Q.

$$0.0339 = \frac{(0.00493)\frac{V^2}{64.4}}{\sqrt{1-\left[(0.00493)\frac{V^2}{64.4}\right]^2}}$$

$$0.0339\sqrt{1-[0.00007655V^2]^2} = 0.00007655V^2$$

$$442.83\ldots\sqrt{1-0.000000006V^4} = V^2 \quad (586)$$

$$196,099.86(1-0.000000006V^4) = V^4$$

$$196,099.86 - 0.0011492V^4 = V^4$$

$$1.0011492V^4 = 196,099.86$$

$$V^4 = 195,874.76$$

$$V = 21.04 \text{ ft/sec.}$$

$$A = 12.57 \text{ ft}^2$$

Control from full pipe flow ⇄ orifice / weir @ $Q = 264.44$ cfs.

AZ Harquahala Valley WPP- HARQ FRS

Smw 12-6-79 R.A.P. 1-23-80

check negative pressures -48-inch pipe 2 2

check negative pressures @ Q = 416 cfs & Q = 265 cfs

$Q = 416 \quad V = \frac{416}{12.57} = 33.09$ fps.

$n = 0.013$, $L = 465$ ft. $H = 66.2$ ft. $K_p = 0.00493$

$K_e \sim 0.6$ (check 1.0, too)

min. pressure @ 1400 ft elev. = 30.6 ft $H_2O$ ($h_a$)

1419.7
1362.3
52.4
-66.2
13.8

Vapor pressure $H_2O$ @ 50°F = 0.41' @ 80°F = 1.17 ft.

$H = \frac{V^2}{2g}\left[1 + K_e + L K_p\right] = \frac{(33.09)^2}{64.4}\left[1.6 + .00493(465)\right]$

$H = 66.18$ (check)

$V^2/2g = 17.00$

$H_{ab} = h_a + h - (1 + K_e + 0.7)\frac{V^2}{2g} - D$

$= 30.6 + 52.4 - \left[(2.3)\frac{(33.09)^2}{64.4}\right] - 4$

$= \underline{39.89 > 1.17 \text{ ft. OK.}}$

6.90

$Q = 265$ cfs, $V = 21.08$ fps, $H = 26.86$ $h = 13.9$

$H_{ab} = 30.6 + 13.9 - \left[(2.3)\frac{(21.08)^2}{64.4}\right] - 4$

$= \underline{24.6 \text{ ft} > 1.17 \text{ ft} \quad OK.}$

$\underline{\text{if } K_p = 1.0, \quad H_{ab} = 21.87 \text{ ft.} > 1.17 \text{ ft}}$

OK.

AZ Harquahala Valley WPP - HARQ. FRS
SML 1-15-80 K.A.S 1-17-80
Drawdown time, Princ. Spwy. 1 1

$$\frac{\Delta \text{ Stor}}{\bar{Q}\,(0.0826)\frac{\text{Ac-ft}}{\text{hr}}} = \text{hr.}$$

TR-60 req. 80% storage drain < 10 days

| Elev. | Q | $\bar{Q}$ | Stor. | Δ Stor. | hr. | Σ hr |
|---|---|---|---|---|---|---|
| 1408.4 | 354.48 | | 8322.0 | | | |
| | | 353.80 | | 512.0 | 17.5 | |
| 1408 | 353.13 | | 7810.0 | | | |
| | | 351.44 | | 1089.7 | 37.5 | 55.05 |
| 1407 | 349.74 | | 6720.3 | | | |
| | | 348.02 | | 1089.7 | 37.9 | 92.97 |
| 1406 | 346.31 | | 5630.6 | | | |
| | | 344.58 | | 900.9 | 31.7 | 124.62 |
| 1405 | 342.85 | | 4729.7 | | | |
| | | 341.10 | | 901.0 | 32.0 | 156.60 |
| 1404 | 339.36 | | 3828.7 | | | |
| | | 337.60 | | 711.7 | 25.5 | 182.12 |
| 1403 | 335.83 | | 3117.0 | | | |
| | | 334.04 | | 711.8 | 25.8 | 207.92 |
| 1402 | 332.26 | | 2405.2 | | | |
| | | 330.46 | | 513.0 | 18.8 | 226.71 approx. 80% |
| 1401 | 328.65 | | 1892.2 | | | |
| | | 326.82 | | 512.9 | 19.0 | 245.71 |
| 1400 | 325.00 | | 1379.3 | | | |
| | | 323.16 | | 322.5 | | |
| 1399 | 321.31 | | 1056.8 | | | $\frac{226.71}{24} = 9.4$ |
| | | 319.44 | | 322.6 | | |
| 1398 | 317.58 | | 734.2 | | | days. |
| | | 315.70 | | 172.1 | | |
| 1397 | 313.81 | | 562.1 | | | < 10 OK |
| | | 311.90 | | 172.1 | | |
| 1396 | 309.98 | | 390.0 | | | |

80% (8322.0 − 414) = 6326.4 Ac-ft.

8322 − 6326.4 = 1995.6 Ac-ft.

check 8322.0 − 0.5(8322) = 1664.4 Ac-ft.

Still less than 10 days.

AZ SML

Harquahala Valley WPP – HARQ.WPS

W.S. 1-16-80 Profile, Transition R.A.P. 1-15-80 & SAF

$$\Delta L = \frac{H_2 - H_1}{S_{ave}} = \frac{\left(d_1 + z_1 + \frac{V_1^2}{2g}\right) - \left(d_2 + z_2 + \frac{V_2^2}{2g}\right)}{0.000283\,(V_{ave})^2/(r_{ave})^{4/3}}$$

$Q = 390$ cfs $V_1 = 31$ fps
$S = 0.0339$

| L TRANSITION | z | d | a | $r_{ave}^{4/3}$ | V | $V_{ave}$ | $\frac{V^2}{2g}$ | H | ΔH | $S_{ave}$ | ΔL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1351.7 | 4 | 12.57 | 1 | 31 | — | 14.92 | −70.62 | — | — | — |
| 5 | −51.53 | 2.65 | $12.192^{1.3/2}$ | 1.2387 | 31.9882 | 31.494 | 15.89 | −70.069 | 0.5511 | 0.2266 | 2.43 < |
| | | 2.70 | $12.436^{1.3/2}$ | 1.2471 | 31.3606 | 31.180 | 15.27 | −69.502 | 1.1180 | 0.2206 | 5.068 |
| 5 | −51.36 | 2.20 | $12.520^{1.3/2}$ | 1.4654 | 31.1502 | 31.255 | 15.07 | −68.627 | 0.8747 | 0.1887 | 4.636 |
| | | 2.21 | $12.578^{1.3/2}$ | 1.4678 | 31.0065 | 31.184 | 14.93 | −68.499 | 1.0034 | 0.1875 | 5.352 |
| 5 | −51.19 | 1.92 | $12.800^{1.2/2}$ | 1.3646 | 30.4688 | 30.7377 | 14.42 | −67.525 | 0.9747 | 0.1959 | 4.974 |
| 10 | −50.85 | 1.62 | $13.681^{1.2/2}$ | 1.2675 | 28.5067 | 29.488 | 12.62 | −65.088 | 2.4365 | 0.1941 | 12.550 |
| | | 1.60 | $13.512^{1.2/2}$ | 1.2601 | 28.8632 | 29.666 | 12.94 | −65.386 | 2.1390 | 0.1977 | 10.822 |
| | | 1.59 | $13.428^{1.2/2}$ | 1.2564 | 29.0438 | 29.756 | 13.10 | 65.538 | 1.9865 | 0.1994 | 9.960 |
| 10 | −50.51 | 1.40 | $14.312^{1.0/2}$ | 1.1729 | 27.2499 | 28.147 | 11.53 | 63.940 | 2.0976 | 0.1912 | 10.9733 |
| | | 1.39 | $14.210^{1.0/2}$ | 1.1686 | 27.4455 | 28.245 | 11.70 | 63.596 | 1.9415 | 0.1932 | 10.050 |
| 10 | −50.17 | 1.29 | $15.48^{1.0/2}$ | 1.1043 | 25.1938 | 26.3197 | 9.86 | 61.32 | 2.276 | 0.1775 | 12.822 |
| | | 1.26 | $15.12^{1.0/2}$ | 1.0904 | 25.794 | 26.6193 | 10.33 | 61.76 | 1.8351 | 0.1839 | 9.978 |

$d_{ave} = 2.63$ $V_{ave} = 28.4$ $F_{ave} = \frac{V}{\sqrt{gA}} = 3.086$ $\tan\alpha = \frac{1}{3F} = 0.108$ $\alpha = 6.165$ (max) > 5.08 OK

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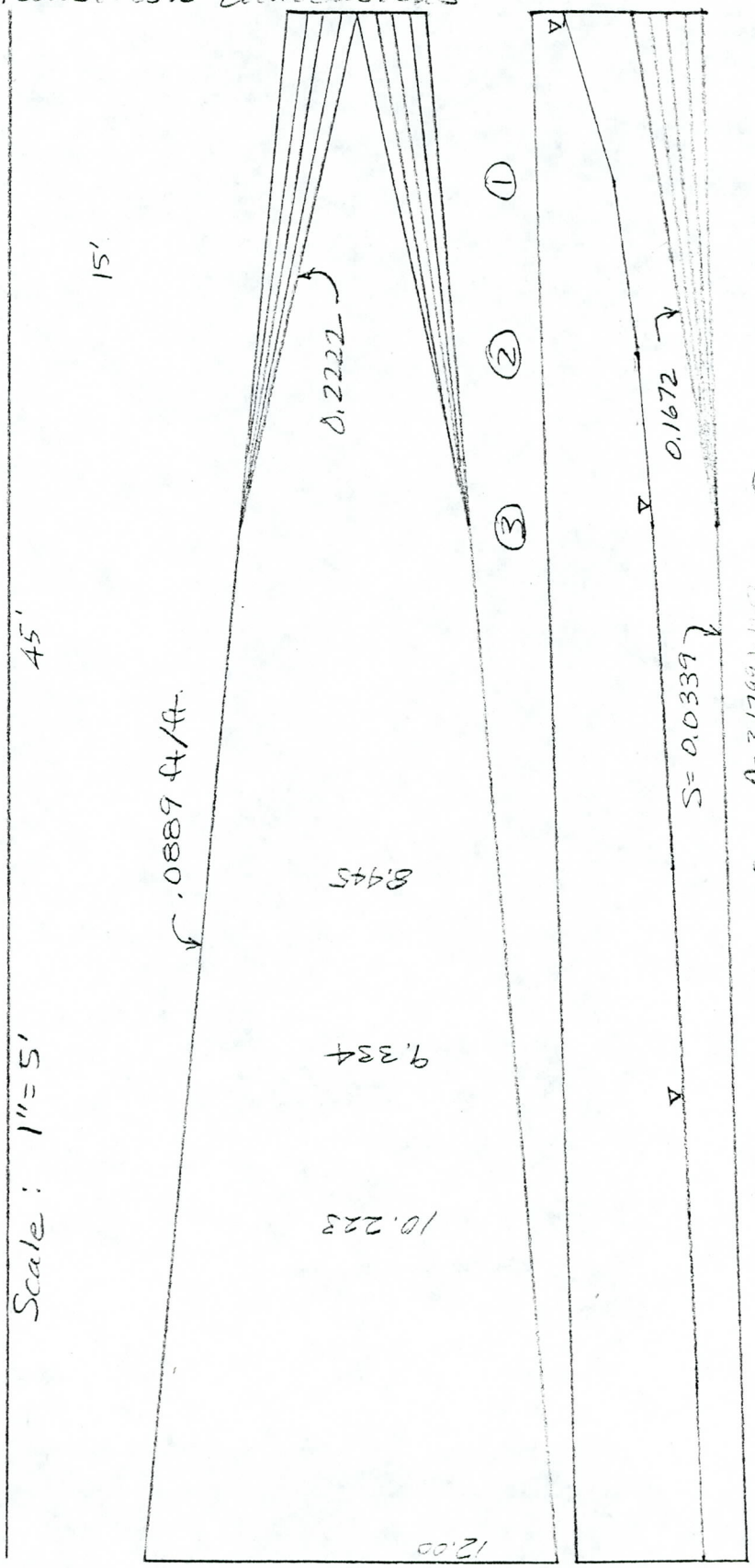
AZ Harquahala Valley WPP – Harq. FRS

SMC 1-16-80 R.A.P. 1-18-80

Transition dimensions 2 5



AZ SMC W/S 1-17-80 Profile, transition & SAF

Harquahala Valley WPP - HPRQ, FRS R.A.P. 1-28-80

(Cont) Vertical Curve & SAF (design vert. curve for smooth flow)

| L | z | d | a | $V_{ave}^{4/3}$ | V | $V_{ave}$ | $\frac{V^2}{2g}$ | H | ΔH | $S_{ave}$ | ΔL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| — | 1350.17 | 1.26 | 15.12 | 1.0904 | 25.794 | 26.6198 | 10.33 | 61.76 | — | — | — |
| 1 (.178) | 1349.992 | 1.26 | 15.12 (1.0554) | 1.0554 | 25.7937 | 25.794 | 10.33 | 61.582 | 0.178 | 0.1784 | 1 |
| 1 (.291) | 49.735 | 1.255 | 15.06 (1.0379) | 1.0531 | 25.9164 | 25.8451 | 10.413 | 61.403 | 0.179 | 0.1795 | 1 |
| 1 (.310) | 49.425 | 1.247 | 14.964 (1.0324) | 1.0435 | 26.0626 | 25.980 | 10.548 | 61.220 | 0.183 | 0.1830 | 1 |
| 1 (.333) | 49.092 | 1.24 | 14.88 (1.0276) | 1.0300 | 26.2097 | 26.1362 | 10.667 | 60.999 | 0.221 | 0.1877 | 1.1774 |
| | | 1.239 | 14.868 (1.0269) | 1.0398 | 26.2308 | 26.1467 | 10.684 | 61.015 | 0.2049 | 0.1861 | 1.1012 |
| | | 1.238 | 14.856 (1.0263) | 1.0393 | 26.2520 | 26.1573 | 10.701 | 61.031 | 0.1890 | 0.1863 | 1.014 |
| 14.766 | 1344.17 | 1.14 | 13.68 (0.9458) | 0.9895 | 28.5088 | 27.3804 | 12.620 | 57.93 | 3.1010 | 0.2144 | 14.463 |
| | | 1.143 | 13.716 (0.9476) | 0.9909 | 28.4339 | 27.343 | 12.554 | 57.867 | 3.1638 | 0.2135 | 14.817 |

$V_1 = 28.4339$ $d_1 = 1.143$ $F_1 = \frac{V^2}{g d_1} = 21.967$ OK, SCS & $F_1$ Bulec = 4.687 > 4.5 Small Dams (close)

$d_2 = \frac{d_1}{2}\left(-1 + \sqrt{8F_1 + 1}\right) = 7.026$ use 7.0 ft.

$d_2' = 1.4\, d_1\, F_1^{0.45} = 6.426$ ft.

$L_B = \frac{4.5 d_2}{F_1^{.38}} = 9.7734$ (9-9 or 10-0) 50.03 drop .14

$J = d_2/3 + d_2' = 8.768$

$S = 0.07\,(d_2) = 0.4918$ use 0,5 ft.

3

5

22 of 335

S=0.0339

Check w/s @ Q=221.23 cfs, D=2.8 ft., V=23.555 fps, A=9.392 ft², R=1.184

| L | Z | d | a | $R^{4/3}_{ave}$ | V | $V_{ave}$ | $\frac{V^2}{2g}$ | H | ΔH | $S_{ave}$ | ΔL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1351.7 | 2.80 | 9.392 (1.184) | | 23.555 | — | 8.616 | 63.116 | — | — | — |
| 5 | 51.53 | 2.0 | 9.014 (1.164) | 1.2386 | 24.543 | 24.049 | 9.353 | 62.883 | 0.233 | 0.1321 | 1.7606 |
| | | 2.2 | 9.9915 (1.227) | 1.2830 | 22.142 | 22.848 | 7.613 | 61.343 | 1.773 | 0.1152 | 15.399 |
| | | 2.07 | 9.3558 (1.1869) | 1.2546 | 23.6463 | | 8.682 | 62.282 | 0.8336 | 0.1256 | 6.635 |
| | | 2.05 | 9.258 (1.1804) | 1.2501 | 23.8961 | 23.726 | 8.867 | 62.447 | 0.6692 | 0.1274 | 5.251 |
| 5 | 51.36 | 1.70 | 9.629 (1.151) | 1.2045 | 22.9754 | 23.4358 | 8.197 | 61.257 | 1.190 | 0.1290 | 9.224 |
| | | 1.65 | 9.342 (1.098) | 1.1901 | 23.6812 | 23.789 | 8.708 | 61.718 | 0.729 | 0.1346 | 5.417 |
| 5 | 51.19 | 1.42 | 9.467 (0.9788) | 1.0634 | 23.3685 | 23.52 | 8.4796 | 61.0896 | 0.6284 | 0.1473 | 4.267 |
| | | 1.425 | 9.50 (0.9812) | 1.065 | 23.2874 | 23.48 | 8.421 | 61.036 | 0.6822 | 0.1466 | 4.655 |
| | | 1.43 | 9.533 (1.0007?) | 1.0667 | 23.2068 | 23.44 | 8.3626 | 60.983 | 0.7354 | 0.1458 | 5.043 |
| 15 | 50.68 | 1.10 | 10.267 (0.8512?) | 0.9279 | 21.548 | 22.38 | 7.2097 | 58.99 | 1.99 | 0.1527 | 13.030 |
| | | 1.12 | 10.454 (0.9032?) | 0.9365 | 21.1622 | 22.184 | 6.9540 | 58.754 | 2.229 | 0.1487 | 14.987 |
| 15 | 50.17 | 1.00 | 12.00 (0.8571) | 0.8435 | 18.4358 | 19.799 | 5.2776 | 56.448 | 2.3064 | 0.1315 | 17.536 |
| | | 0.97 | 11.64 (0.8335) | 0.8294 | 19.006 | 20.084 | 5.6091 | 56.749 | 2.005 | 0.1376 | 14.566 |
| | | 0.975 | 11.70 ([illegible]) | 0.8318 | 18.9085 | 20.0354 | 5.5518 | 56.697 | 2.0572 | 0.1366 | 15.063 |

AZ.
Smc
W/S Profile, 1-16-80
^ full pipe flow
Harquahala Valley WPP - HAEQ. FRS
R.A.P. 1-28-80
4
5

| L | Z | d | a | $r^{4/3}_{ave}$ | V | $V_{ave}$ | $V^2/2g$ | H | ΔH | $S_{ave}$ | ΔL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| — | 50.17 | 0.975 | 11.70 (0.8583) | 0.8318 | 18.9085 | | 5.5518 | 56.697 | — | — | — |
| 1 | 49.992 | 0.975 | 11.70 | 0.7909 | 18.9085 | 18.9085 | 5.5518 | 56.519 | 0.1782 | 0.1279 | 1.3929 |
| | | 0.970+ | 11.640 (0.8350) | 0.7886 | 19.006 | 18.957 | 5.6091 | 56.5711 | 0.1259 | 0.1290 | 0.9759 |
| | | 0.971 | 11.652 (0.8357) | 0.7891 | 18.9864 | 18.9475 | 5.5976 | 56.5606 | 0.1364 | 0.1288 | 1.0594 |
| 1 | 49.735 | 0.963 | 11.556 (0.8298) | 0.7830 | 19.1442 | 19.075 | 5.6910 | 56.3990 | 0.1821 | 0.1315 | 1.385 |
| | | 0.959 | 11.508 (.8268) | 0.7812 | 19.2240 | 19.115 | 5.7386 | 56.4326 | 0.1385 | 0.1324 | 1.0467 |
| 1 | 49.425 | 0.94 | 11.28 (.8127) | 0.7672 | 19.6126 | 19.418 | 5.9729 | 56.3379 | 0.0947 | 0.1391 | 0.6808 |
| | | 0.944 | 11.328 (.8157) | 0.7691 | 19.5295 | 19.377 | 5.9224 | 56.2914 | 0.1412 | 0.1382 | 1.0222 |
| 1 | 49.092 | 0.925 | 11.10 (.8014) | 0.7533 | 19.9306 | 19.7301 | 6.1682 | 56.1852 | 0.1062 | 0.1462 | 0.7264 |
| | | 0.928 | 11.136 (.8033) | 0.7547 | 19.8662 | 19.698 | 6.1284 | 56.1484 | 0.1430 | 0.1455 | 0.9832 |
| 14.766 (.615) | 1344.17 | 0.85 | 10.2 (.7445) | 0.7108 | 21.6892 | 20.78 | 7.305 | 52.325 | 3.8237 | 0.1719 | 22.246 |
| | | 0.70 | 8.4 (.6229) | 0.6397 | 26.3369 | 23.10 | 10.77 | 55.6407 | 0.5077 | 0.2361 | 2.1504 |
| | | 0.794 | 9.528 (.7012) | 0.6844 | 23.2189 | 21.54 | 8.3714 | 53.3354 | 2.8130 | 0.1919 | 14.6588 |
| | | 0.795 | 9.540 (.7020) | 0.6849 | 23.1897 | 21.53 | 8.3504 | 53.3154 | 2.833 | 0.1915 | 14.7941 |

$d_1 = 0.795$ ft. $V_1 = 23.1897$ $F_1 = \frac{V^2}{g d_1} = 21.0072$ (OK) $F_1 = 4.58$ BuRec. >4.5

$d_2 = \frac{d_1}{2}\left(-1 + \sqrt{8F_1 + 1}\right) = 4.77$ ft. $d_2' = 1.4 d_1 F_1^{0.45} =$

<221 cfs approaches poor jump config. accord. Small Dams

AZ Smc

W/S profile < full pit flow 1-17-80

Harquahala Valley WPP-HARQ, FPS R.A.P. 1-23-80

AZ.
SMC 12-27-79 Harquahala Valley WPP - Harq. FRS
Outlet Chan. - Principal Spillway

Work Plan - pp. 4.6-1 & 2

$b = 18'$, $V = 1.9$ fps $d = 6.83$ ft $z = 3$
$S = 0.000215$

for 500 cfs.

d is sequent depth for SAF design; channel is designed @ same depth as SAF floor. (4.5-25)

Preliminary design has similar assumptions, $b = 20'$ $d = 6.8$ ft $S = 0.00018$ — Needs to be varified by downstream design.

$A = 263.16$ ft²

$A = d(3d + b)$

$263.16 = 3d^2 + 18d$

$\frac{-18 \pm \sqrt{18^2 - 4(3)(-263.16)}}{2(3)}$

$d =$

$S = 0.01$

AZ
SmL

Harquahala Valley WPP - HARQ. FRS

1-22-80

Princ. Spwy. tailwater

1

$b = 20$ ft. (plan) $Q = 390$ cfs $S = 0.00018$ $z = 2$

find depth

Kings, 5th Ed. Table 7-11

$$K' = \frac{Qn}{b^{8/3} S^{1/2}} = \frac{(390)(0.035)}{(20)^{8/3}(0.00018)^{1/2}} = 0.3452$$

$V = \frac{Q}{A} = 1.6$ fps.

$\frac{D}{b} = 0.356$ $\underline{D = 7.12 \text{ ft.}}$, approx $d_2$

if $n = 0.030$, $K' = 0.2959$; $\frac{D}{b} = 0.3288$, $\underline{d = 6.58 \text{ ft.}}$

if $z = 3$, $n = 0.035$

$\frac{D}{b} = 0.3287$ $\underline{D = 6.57}$

if $z = 3$, $n = 0.030$

$\frac{D}{b} = 0.305$ $D = 6.10$ ft.

I visualize lots of cobbles, but lower n is more conservative for setting tailwater depth.

Check $Q = 221.23$ cfs, $n = 0.03$, $b = 20$, $S = 0.00018$, $z = 2$

$V = 1.5$ fps.

$$K' = \frac{(221.23)(0.03)}{(20)^{8/3}(.00018)^{1/2}} = 0.1678 \quad \frac{D}{b} = 0.2437 \quad D = 4.87 \text{ ft.}$$

OK, > 4.77 $D_2$ for that Q.

AZ. Harquahala Valley WPP- HARQ. FRS

SML 1-18-80 R.A.P. 1-18-80

Stage / Discharge for gated drawdown 2 2

18" gate, $A = 1.77\ ft^2$ C varies

orifice ℄ el. = 1371.5 $Q = Ch^{1/2}(14.29)$

| Elev. | h | C | Q |
|---|---|---|---|
| 1387.3 | 15.8 | 0.597 | 33.70 |
| 1386 | 14.5 | 0.597 | 32.28 |
| 1384 | 12.5 | 0.598 | 30.02 |
| 1382 | 10.5 | 0.598 | 27.52 |
| 1380 | 8.5 | 0.600 | 24.84 |
| 1378 | 6.5 | 0.600 | 21.72 |
| 1376 | 4.5 | 0.602 | 18.13 |
| 1374 | 2.5 | 0.603 | 13.54 |
| 1372 | 0.5 | 0.616 | 6.19 |
| 1370.5 | 0 | — | 0 |

Curiosity

$y = 4.2$ & $x = 4$, $V = \sqrt{\frac{(32.2)(4)^2}{(2)(4.2)}} = 7.83$ fps, $Q = 13.86$ cfs.

$\sim h = 2.5$ for both pipes

check $x = 12'$, $y = 2.04$

$F_{x\,max} = Q\frac{w}{g}(V_o - V_f) = 33.7\left(\frac{62.4}{32.2}\right)(19.04 - 0)$

$F_{max} = 1243.44\#$ w/full hydros. head outside of riser.

COMPUTATION SHEET
SCS-ENG-523 Rev. 8-69

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

7-28 QA 335

| STATE | | PROJECT | | |
|---|---|---|---|---|
| Arizona | | Harquahala Valley WPP- Harquahala FRS | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. |
| R.A.P. | 1-21-80 | | | |
| SUBJECT | | | | SHEET 2 OF |
| Drawdown time - 18" gate | | | | |

$$\frac{\Delta \text{ Stor}}{\overline{Q}\ (0.0826)\ \frac{\text{Ac-ft}}{\text{hr.}}} = \text{hr}$$

| Elev. | Q | $\overline{Q}$ | Stor. | Δ Stor | hr | Σ hr |
|---|---|---|---|---|---|---|
| 1387.3 | 33.70 | | 52. - | | | |
| | | 32.99 | | 21.4± | 7.85 | |
| 1386 | 32.28 | | 30.6 | | | |
| | | 31.15 | | 14.04 | 5.46 | 13.31 |
| 1384 | 30.02 | | 16.56 | | | |
| | | 28.77 | | 8.60 | 3.62 | 16.93 |
| 1382 | 27.52 | | 7.96 | | | |
| | | 26.18 | | 4.80 | 2.22 | 19.15 |
| 1380 | 24.84 | | 3.16 | | | |
| | | 23.28 | | 2.08 | 1.08 | 20.23 |
| 1378 | 21.72 | | 1.08 | | | |
| | | 19.92 | | 0.76 | 0.46 | 20.69 |
| 1376 | 18.13 | | 0.32 | | | |
| | | 15.83 | | 0.26 | 0.20 | 20.89 |
| 1374 | 13.54 | | 0.06 | | | |
| | | 9.86 | | 0.04 | 0.05 | 20.94 |
| 1372 | 6.19 | | 0.02 | | | |
| | | 3.09 | | | | |
| 1370.5 | 0.0 | | | | | |

Selected 18" gate, Invert raised to 1373.31

AZ
SML

Harquahala Valley WPP-HARQ.FRS

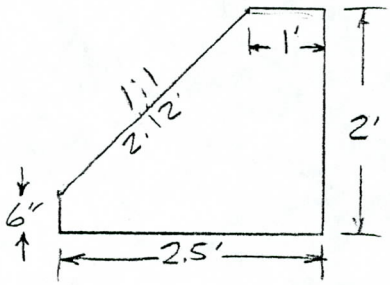
1-18-80 R.A.P. 1-23-80

trashrack veloc. for drawdown (18-inch) / /

assume peak Q of 33.70 cfs must enter top of 1/2, 60" CMP screen through trash rack.

$C = \pi d$

1637




ave. length of sloped area

$C = \frac{\pi 5 + \pi 2}{4} = 5.5$ ft.

$A = \frac{\pi(2)^2}{(4)(2)} + (5.5)(2.12) + (0.5)(0.5)\pi(5)$

$A = 17.16$ ft²

$V = \frac{Q}{A} = \frac{33.7}{17.16} = 1.96$ fps $< 2.5$ fps.

holes in screen should balance area taken by bars (1" dia)

Vel. in. riser

$\left(\frac{\pi d^2}{4}\right)\frac{1}{2} = 9.82$ ft²

$V = \frac{Q}{A} = \frac{33.70}{9.82} = 3.43$ fps.

```
DAMS2 XEQ   11/3  0/79
      REV 06/18/73

********************************* 80-80 LIST OF INPUT DATA ****************

DAMS2      110179    HARQUAHALA FRS
COMMENT    72-HR STORM HYDROGRAPHS-481N PRIN SPWY- 465 feet long
BTMWIDTH   FEET      150
STRUCTURE  HAFRS     HARQUAHALA FRS
                     1370       0.0                    0.0
                     1376       0.2                    0.32
                     1380       1.52                   3.16
                     1384.      5.33                   16.56
                     1387.3     11.79      0.0         45.0
                     1388       13.45      40.5        52.76
                     1392       33.59      317.1       143.42
                     1396       107.32     333.2       389.96
                     1400       408.08     348.5       1379.28
                     1402       617.81     355.9       2405.18
                     1404       805.72     363.2       3828.72
                     1406       996.17     370.3       5630.62
                     1408       1183.16    377.3       7809.96
                     1410       1377.12    384.2       10370.24
                     1412       1572.24    390.9       13319.58
                     1414       1752.07    397.6       16643.88
                     1416       1940.16    404.1       20336.12
                     1418       2124.77    410.5       24401.05
                     1420       2253.24    416.8       28779.07
                     1435       3550.0     461.47      64230.0
ENDTABLE
PSRATING
COMMENT    465 FEET LONG (P.S.)
CLPROFILE                      HARQUAHALA FRS BUREC STATIONING
           46597     1425      46598      1425        46599      1425
           46600     1399.7    47170      1396        47855      1395.5
           48120     1394.6    48650      1396        49180      1395
           49610     1396.2    49700      1395.2      53110      1395.5
           54420     1397.8    54500      1395        55130      1397
           56500     1395.5    58240      1397        59740      1394.2
           61410     1396      62140      1396.3      63100      1395.2
           64530     1396.3    65780      1394        66560      1395
           66970     1391.6    67440      1396        67790      1394.4
           68480     1396.4    69780      1398        69810      1397
           71610     1398.5    71920      1396.5      72520      1397.5
           73230     1391.2    74680      1384        75420      1390
           76300     1390.4    76500      1393        77890      1398
           79300     1391.8    79860      1396.8      80640      1393
           81500     1402      82690      1402        83810      1398.3
           85450     1399.5    85770      1396.3      86500      1402
           87520     1397      88400      1396        89210      1398.8
           91530     1396.6    93540      1400        94230      1397.8
           95800     1398.7    97695      1393.7      98340      1396.3
           101500    1396      102500     1396        104620     1377
           105330    1407      105410     1420        105510     1425
```

DAMS2 XEQ 11/3 0/79
REV 06/18/73

********** 80-80 LIST OF INPUT DATA **********

```
ENDTABLE
ESRATING  1          1.0        FUJIMOTO
ESRATING  2.34       6.62       14.11      22.24      34.44      45.27
ESRATING  57.04      71.96      85.86      100.56     116.02     132.19
ESCREST   ELEV
WSDATA    IC         81         102.3      5
POOLDATA  AC-FT                 45         369
TEMPLATE  14         3          2
QDIRECT              1.60       1.76       2.52       5.49
GO,DESIGN LE
HYD       72HR                  FREEBOARD HYDRO
                     0.5        15.0       102.3      0.0
                     0.2        0.22       0.74       3.05       9.31
                     25.26      53         97.73      173.54     270.85
                     391        525        669        824        982
                     1142       1300       1456       1616       1825
                     2128       2489       2845       3208       3575
                     3930       4272       4588       4882       5152
                     5491       7053       10958      15741      10963
                     26150      31212      36073      40387      44138
                     47310      50013      51964      52174      49592
                     45436      41680      37906      34227      30921
                     28125      25621      24186      22992      21997
                     20943      19400      17807      16350      15040
                     13864      12838      11963      11328      10827
                     10438      10161      9850       9442       9029
                     8660       8332       8035       7778       7575
                     7408       7285       7198       7118       6965
                     6651       6290       5963       5656       5372
                     5124       4907       4748       4626       4534
                     4458       4336       4114       3869       3637
                     3421       3226       3049       2910       2797
                     2714       2651       2604       2569       2540
                     2521       2506       2493       2485       2479
                     2474       2470       2468       2466       2452
                     2363       2099       1800       1520       1250
                     1003       780        592        448        341
                     256        195        149        111        85
                     64.67      48.55      36.61      27.32      20.46
                     15.06      10.74      7.79       5.34       3.45
                     2.18       1.33       0.79       0.41       0.13
                     0.05       0.0

ENDTABLE
GO,HYD    L
HYD       72HR                  EMERGENCY SPWY HYDRO
                     0.5        20.0       102.3      0.0
                     0.0        0.0        0.01       0.08       0.48
                     1.28       4.35       12.68      30.38      61.79
                     113.35     187.75     274.42     373.14     485.75
```

DAMS2 XEQ 11/3 0/79
REV 06/18/73

********** 80-80 LIST OF INPUT DATA **********

| | | | | |
|---|---|---|---|---|
| 602.96 | 724.98 | 848.95 | 972.73 | 1095 |
| 1241 | 1759 | 3053 | 4752 | 6754 |
| 8886 | 11062 | 13268 | 15366 | 17311 |
| 19075 | 20674 | 21958 | 22432 | 21594 |
| 19975 | 18499 | 16972 | 15448 | 14061 |
| 12879 | 11906 | 11223 | 10733 | 10326 |
| 9877 | 9183 | 8458 | 7789 | 7185 |
| 6640 | 6163 | 5757 | 5462 | 5230 |
| 5052 | 4925 | 4781 | 4589 | 4394 |
| 4219 | 4063 | 3921 | 3799 | 3703 |
| 3624 | 3567 | 3527 | 3490 | 3418 |
| 3266 | 3090 | 2931 | 2782 | 2643 |
| 2523 | 2417 | 2340 | 2280 | 2236 |
| 2200 | 2140 | 2031 | 1911 | 1797 |
| 1691 | 1595 | 1508 | 1439 | 1384 |
| 1343 | 1312 | 1289 | 1272 | 1258 |
| 1249 | 1241 | 1235 | 1232 | 1229 |
| 1226 | 1225 | 1224 | 1223 | 1216 |
| 1173 | 1042 | 894 | 755 | 621 |
| 498 | 388 | 294 | 223 | 170 |
| 127 | 97.4 | 74 | 55 | 42 |
| 32.2 | 24.2 | 18.2 | 13.6 | 10.2 |
| 7.5 | 5.3 | 3.9 | 2.7 | 1.7 |
| 1.09 | .66 | .39 | .21 | .07 |
| .02 | 0.0 | | | |

ENDTABLE
GO,HYD L
ENDJOB

**********

********************************** BASIC DATA **********************************

ARID-SEMIARID CLIMATE AREA DESIGN CLASS C

STORM DISTRIBUTION.....SCS DESIGN STORM RAINFALL DISTRIBUTION. (CHAPTER 21, NEH4 AND SCS EM-27)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| P-PS1 DAY | P-PS10 DAY | P-ES | P-FB | CN | DA-SM | TC/L | -/H |
| 1.60 | 1.76 | 2.52 | 5.49 | 81.00 | 102.30 | 5.00 | .00 |
| CONDUITS | COND L | D/H | -/H | PS N | KI | WEIR L | TW EL |
| .00 | .00 | .00 | .00 | .000 | .00 | .00 | .00 |
| PERM POOL | CREST PS | FP SEL | BASEFLOW | 2ND STG | ORF H | ORF L | START |
| .00 | 45.00 | 369.00 | .00 | .00 | .00 | .00 | .00 |
| ES1 | ES2 | ES3 | ES4 | ES5 | Z ES | EXIT N | EXIT S |
| .00 | .00 | .00 | .00 | .00 | .00 | .040 | .000 |
| ES TYPE | ES L | ES N | BW1 | BW2 | BW3 | BW4 | BW5 |
| 0 | 0 | .000 | 150.00 | .00 | .00 | .00 | .00 |
| ES CODE | INCREMENT | | | Q1 | Q2 | Q3 | Q4 |
| 1.000 | 1.000 | | | 2.340 | 6.620 | 14.110 | 22.240 |
| Q5 | Q6 | Q7 | Q8 | Q9 | Q10 | Q11 | Q12 |
| 34.440 | 45.270 | 57.040 | 71.960 | 85.860 | 100.560 | 116.020 | 132.190 |

DAMS2 XEQ 11/3 0/79 HARQUAHALA FRS
REV 06/18/73 HARQUAHALA FRS

*****ENGINEERING DIVISION MUST APPROVE THE AREAL CORRECTIONS
DESIGN .53600 PS-1 DAY .93200 PS-10 DAY .96600

| | | | |
|---|---|---|---|
| CREST PS | 1387.32 FT | 45.2 ACFT | 11.83 AC |
| SED ACCUM | 1396.21 FT | 414.0 ACFT | 123.01 AC |
| BASEFLOW | 1387.32 FT | 45.2 ACFT | 11.83 AC |

SCS-PSH RAINFALL 1 DAY =****** IN 10 DAY =****** IN
RUNOFF 1 DAY = 1.60 IN 10 DAY = 1.76 IN

CLIMATIC INDEX = 1.00

| TYPE | EMAX | VMAX | AMAX | QMAX |
|---|---|---|---|---|
| SCS-PSH | 1408.49 FT | 8403.8 ACFT | 1230.87 AC | 378.9 C |

PS STORAGE 7989.8 ACFT

DDT TEST 1401.32 FT 2012.0 ACFT 353.1 CFS
CONTROL IS .200 DETENTION STORAGE

DRAWDOWN TIME = 8.77 DAYS (LIMIT = 10.00 DAYS)

**********

RATING TABLE NUMBER 1

| | E FEET | Q CFS | V AC FT | A ACRE |
|---|---|---|---|---|
| 1 | 1370.00 | .00 | .00 | .00 |
| 2 | 1376.00 | .00 | .32 | .20 |
| 3 | 1380.00 | .00 | 3.16 | 1.52 |
| 4 | 1384.00 | .00 | 16.56 | 5.33 |
| 5 | 1387.30 | .00 | 45.00 | 11.79 |
| 6 | 1388.00 | 40.50 | 52.76 | 13.45 |
| 7 | 1392.00 | 317.10 | 143.42 | 33.59 |
| 8 | 1396.00 | 333.20 | 389.96 | 107.32 |
| 9 | 1400.00 | 348.50 | 1379.28 | 408.08 |
| 10 | 1402.00 | 355.90 | 2405.18 | 617.81 |
| 11 | 1404.00 | 363.20 | 3828.72 | 805.72 |
| 12 | 1406.00 | 370.30 | 5630.62 | 996.17 |
| 13 | 1408.00 | 377.30 | 7809.96 | 1183.16 |
| 14 | 1410.00 | 384.20 | 10370.24 | 1377.12 |
| 15 | 1412.00 | 390.90 | 13319.58 | 1572.22 |
| 16 | 1414.00 | 397.60 | 16643.88 | 1752.07 |
| 17 | 1416.00 | 404.10 | 20336.12 | 1940.16 |
| 18 | 1418.00 | 410.50 | 24401.05 | 2124.77 |
| 19 | 1420.00 | 416.80 | 28779.07 | 2253.24 |
| 20 | 1435.00 | 461.47 | 64230.00 | 3550.00 |

ES CREST 1408.49 FT 8403.8 ACFT 1230.87 AC

PS STORAGE 7989.8 ACFT

STARTING E 1396.21 FT 414.0 ACFT 123.01 AC 333.6 CFS

SCS-ESH D= 6.00 HR P= 2.52 IN Q= 2.52 IN
TC= 5.00 HR CN= 81.00 V= 13609.3 ACFT
PEAK 30895.2 CFS AT 5.49 HRS

SCS-FBH D= 6.00 HR P= 5.49 IN Q= 5.49 IN
TC= 5.00 HR CN= 81.00 V= 29648.8 ACFT
PEAK 67307.4 CFS AT 5.49 HRS

**********

RATING TABLE NUMBER 2

| | E FEET | Q CFS | V AC FT | A ACRE |
|---|---|---|---|---|
| 1 | 1387.32 | 1.00 | 45.19 | 11.83 |
| 2 | 1389.08 | 93.83 | 70.24 | 18.89 |
| 3 | 1390.85 | 219.46 | 111.42 | 27.78 |
| 4 | 1392.61 | 318.66 | 167.35 | 44.84 |
| 5 | 1394.37 | 325.70 | 275.17 | 77.36 |
| 6 | 1396.14 | 333.44 | 405.65 | 117.80 |
| 7 | 1397.90 | 338.47 | 730.60 | 250.49 |
| 8 | 1399.67 | 347.11 | 1289.68 | 383.17 |
| 9 | 1401.43 | 353.50 | 2071.91 | 558.38 |
| 10 | 1403.20 | 360.04 | 3212.70 | 730.36 |
| 11 | 1404.96 | 366.43 | 4648.41 | 897.38 |
| 12 | 1406.73 | 372.71 | 6379.78 | 1064.16 |
| 13 | 1408.49 | 378.90 | 8403.63 | 1230.86 |
| 14 | 1409.82 | 943.40 | 10120.18 | 1359.40 |
| 15 | 1411.14 | 2112.08 | 12007.50 | 1488.59 |
| 16 | 1413.53 | 5621.21 | 15827.59 | 1709.66 |
| 17 | 1416.44 | 11092.84 | 21207.22 | 1981.17 |
| 18 | 1421.75 | 20269.00 | 32844.82 | 2404.18 |
| 19 | 1428.37 | 20380.24 | 50675.72 | 2977.09 |
| 20 | 1435.00 | 20492.49 | 72303.37 | 3550.00 |

| TYPE | BW | EMAX | VMAX | AMAX | HP | V-ES | Q-PS | Q-ES | Q-TOT | D/C | V/C | S/C | S/C.25 | D-ES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SCS-ESH | 150.0 | 1411.56 | 12644.2 | 1529.7 | 3.07 | 4240.6 | 389. | 2308. | 2697. | 1.94 | 7.91 | .019 | .025 | 59.8 |

| TYPE | BW | EMAX | VMAX | AMAX | HP | V-ES | Q-PS | Q-ES | Q-TOT | D/C | V/C | S/C | S/C.25 | D-ES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SCS-FBH | 150.0 | 1417.79 | 23947.2 | 2105.0 | 9.29 | 15543.6 | 410. | 12843. | 13253. | 6.11 | 14.02 | .013 | .017 | 80.7 |

VOLUME FILL= 3422758. CY, MAX. HEIGHT= 40.8 FT
TOP WIDTH= 14.0 FT. TOP LENGTH= 58797.1 FT
AREA OF DAM= 167.57 AC. AREA TO SEED= 167.57 AC

235 of 385

********** BASIC DATA **********

ARID-SEMIARID CLIMATE AREA

DESIGN CLASS C

STORM DISTRIBUTION....FREEBOARD HYDRO

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| P-PS1 DAY | P-PS10 DAY | P-ES | P-FB | CN | DA-SM | TC/L | -/H |
| 1.60 | 1.76 | 2.52 | 5.49 | 81.00 | 102.30 | 5.00 | .00 |
| CONDUITS | COND L | D/H | -/H | PS N | KI | WEIR L | TW EL |
| .00 | .00 | .00 | .00 | .000 | .00 | .00 | .00 |
| PERM POOL | CREST PS | FP SLO | BASEFLOW | 2ND STG | ORF H | ORF L | START |
| .00 | 45.00 | 369.00 | .00 | .00 | .00 | .00 | .00 |
| ES1 | ES2 | ES3 | ES4 | ES5 | Z ES | EXIT N | EXIT S |
| .00 | .00 | .00 | .00 | .00 | .00 | .040 | .000 |
| ES TYPE | ES L | ES N | BW1 | BW2 | BW3 | BW4 | BW5 |
| 0 | 0 | .000 | 150.00 | .00 | .00 | .00 | .00 |
| ES CODE | INCREMENT | | | Q1 | Q2 | Q3 | Q4 |
| 1.000 | 1.000 | | | 2.340 | 6.620 | 14.110 | 22.240 |
| Q5 | Q6 | Q7 | Q8 | Q9 | Q10 | Q11 | Q12 |
| 34.440 | 45.270 | 57.040 | 71.960 | 85.860 | 100.560 | 116.020 | 132.190 |

DAMS2 XEQ 11/3 0/79
REV 06/18/73

HARQUAHALA FRS
HARQUAHALA FRS

| | | | |
|---|---|---|---|
| CREST PS | 1387.32 FT | 45.2 ACFT | 11.83 AC |
| SED ACCUM | 1396.21 FT | 414.0 ACFT | 123.01 AC |
| ES CREST | 1408.49 FT | 8403.6 ACFT | 1230.87 AC |
| PS STORAGE | 7989.8 ACFT | | |

*****INPUT( .00) TO INTERPOLATION ROUTINE IS BELOW ARRAY LIMIT( 45.19).

| | | | | |
|---|---|---|---|---|
| STARTING E | 1370.00 FT | .0 ACFT | .00 AC | 1.0 CFS |

**********

RATING TABLE NUMBER 2

| | E FEET | Q CFS | V AC FT | A ACRE |
|---|---|---|---|---|
| 1 | 1387.32 | 1.00 | 45.19 | 11.83 |
| 2 | 1389.08 | 93.83 | 70.24 | 18.89 |
| 3 | 1390.85 | 219.46 | 111.42 | 27.78 |
| 4 | 1392.61 | 318.66 | 167.35 | 44.84 |
| 5 | 1394.37 | 325.70 | 275.17 | 77.36 |
| 6 | 1396.14 | 333.44 | 405.65 | 117.80 |
| 7 | 1397.90 | 338.47 | 730.60 | 250.49 |
| 8 | 1399.67 | 347.11 | 1289.68 | 383.17 |
| 9 | 1401.43 | 353.50 | 2071.91 | 558.38 |
| 10 | 1403.20 | 360.04 | 3212.70 | 730.36 |
| 11 | 1404.96 | 366.43 | 4648.41 | 897.38 |
| 12 | 1406.73 | 372.71 | 6379.78 | 1064.16 |
| 13 | 1408.49 | 378.90 | 8403.63 | 1230.86 |
| 14 | 1409.82 | 943.40 | 10120.18 | 1359.40 |
| 15 | 1411.14 | 2112.08 | 12007.50 | 1488.59 |
| 16 | 1413.53 | 5621.21 | 15827.59 | 1709.66 |
| 17 | 1416.44 | 11092.84 | 21207.22 | 1981.17 |
| 18 | 1421.75 | 20268.00 | 32644.82 | 2404.18 |
| 19 | 1428.37 | 20380.24 | 50675.72 | 2977.09 |
| 20 | 1435.00 | 20492.49 | 72303.37 | 3550.00 |

*****INPUT( .00) TO INTERPOLATION ROUTINE IS BELOW ARRAY LIMIT( 45.19).

| TYPE | BW | EMAX | VMAX | AMAX | HP | V-ES | Q-PS | Q-ES | Q-TOT | D/C | V/C | S/C | S/C.25 | D-ES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FLOOD HYD | 150.0 | 1419.64 | 27964.1 | 2229.9 | 11.14 | 19560.5 | 416. | 16004. | 16420. | 7.07 | 15.08 | .012 | .017 | 102.5 |

********** BASIC DATA **********

ARID-SEMIARID CLIMATE AREA

DESIGN CLASS C

STORM DISTRIBUTION.....EMERGENCY SPWY HYDRO

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| P-PS1 DAY<br>1.60 | P-PS10 DAY<br>1.76 | P-ES<br>2.52 | P-FB<br>5.49 | CN<br>81.00 | DA-SM<br>102.30 | TC/L<br>5.00 | -/H<br>.00 |
| CONDUITS<br>.00 | COND L<br>.00 | D/H<br>.00 | -/H<br>.00 | PS N<br>.000 | KI<br>.00 | WEIR L<br>.00 | TW EL<br>.00 |
| PERM POOL<br>.00 | CREST PS<br>45.00 | FP SEL<br>369.00 | BASEFLOW<br>.00 | 2ND SIG<br>.00 | ORF H<br>.00 | ORF L<br>.00 | START<br>.00 |
| ES1<br>.00 | ES2<br>.00 | ES3<br>.00 | ES4<br>.00 | ES5<br>.00 | Z ES<br>.00 | EXIT N<br>.040 | EXIT S<br>.000 |
| ES TYPE<br>0 | ES L<br>0 | ES N<br>.000 | BW1<br>150.00 | BW2<br>.00 | BW3<br>.00 | BW4<br>.00 | BW5<br>.00 |
| ES CODE<br>1.000 | INCREMENT<br>1.000 | | | Q1<br>2.340 | Q2<br>6.620 | Q3<br>14.110 | Q4<br>22.240 |
| Q5<br>34.440 | Q6<br>45.270 | Q7<br>57.040 | Q8<br>71.960 | Q9<br>85.860 | Q10<br>100.560 | Q11<br>116.020 | Q12<br>132.190 |

| | | | |
|---|---|---|---|
| CREST PS | 1387.32 FT | 45.2 ACFT | 11.83 AC |
| SED ACCUM | 1396.21 FT | 414.0 ACFT | 123.01 AC |
| ES CREST | 1408.49 FT | 8403.8 ACFT | 1230.87 AC |
| PS STORAGE | 7989.8 ACFT | | |

*****INPUT( .00) TO INTERPOLATION ROUTINE IS BELOW ARRAY LIMIT( 45.19).

| | | | | |
|---|---|---|---|---|
| STARTING E | 1370.00 FT | .0 ACFT | .00 AC | 1.0 CFS |

**********

RATING TABLE NUMBER 2

| | E FEET | Q CFS | V AC FT | A ACRE |
|---|---|---|---|---|
| 1 | 1387.32 | 1.00 | 45.19 | 11.83 |
| 2 | 1389.08 | 93.83 | 70.24 | 18.89 |
| 3 | 1390.85 | 219.46 | 111.42 | 27.78 |
| 4 | 1392.61 | 318.66 | 167.35 | 44.84 |
| 5 | 1394.37 | 325.70 | 275.17 | 77.36 |
| 6 | 1396.14 | 333.44 | 405.65 | 117.80 |
| 7 | 1397.90 | 338.47 | 730.60 | 250.49 |
| 8 | 1399.67 | 347.11 | 1289.68 | 383.17 |
| 9 | 1401.43 | 353.50 | 2071.91 | 558.38 |
| 10 | 1403.20 | 360.04 | 3212.70 | 730.36 |
| 11 | 1404.96 | 366.43 | 4648.41 | 897.38 |
| 12 | 1406.73 | 372.71 | 6379.78 | 1064.16 |
| 13 | 1408.49 | 378.90 | 8403.63 | 1230.86 |
| 14 | 1409.82 | 943.40 | 10120.18 | 1359.40 |
| 15 | 1411.14 | 2112.08 | 12007.50 | 1488.59 |
| 16 | 1413.53 | 5621.21 | 15827.59 | 1709.66 |
| 17 | 1416.44 | 11092.84 | 21207.22 | 1981.17 |
| 18 | 1421.75 | 20268.00 | 32844.82 | 2404.18 |
| 19 | 1428.37 | 20380.24 | 50675.72 | 2977.09 |
| 20 | 1435.00 | 20492.49 | 72303.37 | 3550.00 |

*****INPUT( .00) TO INTERPOLATION ROUTINE IS BELOW ARRAY LIMIT( 45.19).

| TYPE | BW | EMAX | VMAX | AMAX | HP | V-ES | Q-PS | Q-ES | Q-TOT | D/C | V/C | S/C | S/C.25 | D-ES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FLOOD HYD | 150.0 | 1412.80 | 14613.6 | 1644.6 | 4.31 | 6209.9 | 394. | 4112. | 4506. | 2.86 | 9.59 | .016 | .022 | 87.5 |

Table

48-inch conduit - 465 ft long

AZ. Harquahala Valley WPP - HARQ.FRS

Sue 2-21-80

Summarize Program Output, DAMS2 /

Final Design Option

Check peak freeboard hydrograph with no principal spillway.

Input

Structure card, 0 output PS.
Fujimoto entrance w/unit ES RATING
Crest elev. 1408.4
72-hour storms, em. spwy & freeboard

Output - FREEBOARD

EMAX = 1419.81 VMAX = 28351.7 AMAX = 2241.0

HP = 11.41 V-ES = 20,060.8 Q-PS = 0

Q-ES = 16,425. Q-TOT. = 16,425. D/C = 7.20

V/C = 15.22 S/C = 0.012 S/C,25 = 0.016

D-ES = 123.0

EMERGENCY SPILLWAY

EMAX = 1413.0 VMAX = 14,941.8 AMAX = 1662.4

HP = 4.60 V-ES = 6650.9 Q-PS. = 0

Q-ES = 4554. Q-TOT = 4554. D/C = 3.06

V/C = 9.92 S/C = 0.016 S/C,25 = 0.022

D-ES = 155.0

DRAIN OUTLET

AZ
SMC

Harquahala Valley WPP- HARQ.FRS

5-20-80

Drain Outlet

The Drain Outlet must be set low to drain as much of the reservoir as possible. Station 746+00 was selected because it is the lowest natural drainage before the CAP canal is routed adjacent to the hills, which could be a restriction in the flow of floodwaters to the principal spillway.

This location is in the upper part of Sediment Reach 3. The projected level sediment storage would be ten feet above the Drain Outlet entrance. The geologist (Addendum to Ecologic Investigation Report, May 15, 1980) has estimated a possible sand-size sediment storage requirement of 1960 cubic feet at the Drain Outlet on an average annual basis.

The downstream natural channel will be stable for the maximum discharge from a 24-inch pipe.

As at New Tank Outlet, there are four options for discharging the water. As a "substitute principal spillway", the first two options are not viable since the discharge volume could be great. The third option (over the top of the CAP canal) is not viable because the inlet elevation is below the canal lining. The fourth option (under the CAP canal) appears to be the best selection. The outlet invert is sixteen feet below the natural ground

AZ Harquahala Valley WPP- HARQ. FRS
SML 5-20-80
Drain Outlet - cont. 4 4

downstream from the CAP. No specific discharge is required, so reduced discharge dued to tailwater is not a problem.

The Drain Outlet will have a standard (TR46-type) slide gate entrance structure, 24-inch prestressed concrete cylinder pipe with cradle and collars and submerged pipe outlet basin. It will pass under the CAP canal. The outlet basin will have 2:1 side slopes on three sides. The slope the pipe emerges from will be 1:5:1 and riprapped for extra protection. The floor of the basin and 5 feet up each side for the first 15 feet from the pipe will be riprapped to protect from early and low flows.

The gate can be managed to suit the Flood Control District. If left open, sediment will generally pass through to the basin. Basin soils are expected to be GP-GM or close to that classification, therefore, the basin will drain easily. Mosquitos are not expected to be a problem.

Sediment removal will be a regular maintenance requirement, as needed. Expect very little most years.

AZ
SMC 4-25-80 Harquahala Valley WPP HARQ.FRS
R.A.P. 4/28/80

Veg. Outlet #2, peak discharge 1 2

(Drain)

H = 1408.4 - (1358+1) = 49.4 ft., say 50 ft. Qp
(assume gate opened after storm w/ water surface at crest of emerg. spwy.)

L = 460 ft. D = 24" n ≈ 0.013 full pipe flow

$$Q = CA\sqrt{2gh}$$

$$C = \frac{1}{\sqrt{1 + K_e + L K_p}}$$

$$C = \left[1 + 1 + 460\,(0.0124)\right]^{-1/2} = 0.36$$

$$Q_p = (0.36)(3.14)\left[(2)(32.2)(50)\right]^{1/2} = 64.2 \text{ cfs}$$

$$V_p = \frac{64.2}{3.14} = 20.45 \text{ fps} \quad \text{(gate 1st opened)}$$

Check more likely H from crest principal spwy.

H = 1387.3 − 1359 = 28.3, use 29 ft.

$$Q = (0.36)(3.14)\left[(64.4)(29)\right]^{1/2} = 43.8 \text{ cfs}$$

$$V = \frac{48.8}{3.14} = 15.5 \text{ fps} \quad \text{(gate 1st opened)}$$

H after flow fills basin = 1408.4 − 1374 = 34.4 ft.
or 1387.3 − 1374 = 13.3 ft.

H = 34.4 ft, Q = 53.2 cfs, V = 16.9 fps >> 5/1/80 RAP.

H = 13.3 ft., Q = 33.1 cfs, V = 10.5 fps. >> 5/1/80

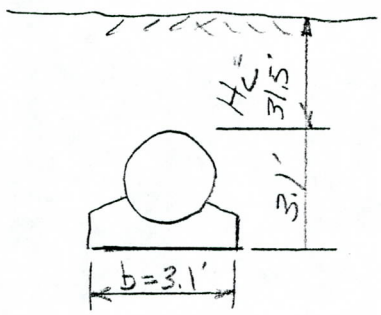
AZ — Harquahala Valley WPP-HARQ. FRS

SMC 4-24-80 R.A.P. 4/25/80

Pipe loading — LC#1 Outlet#2 1 3

Drain Outlet

TR-5 ES-113 guide




assume $b_c = 33"$; 2.75 ft.

$H_c = 31.5$ ft. $\gamma_s \approx 136$ #/ft³

assume complete projection.

ES-114 Case a $\delta = 1$

assume $K_N$ 0.4 & $K_\mu = 0.19$

$$\rho = \frac{p b_c}{b_c} = \frac{3.1}{2.75} = 1.13$$

$$\delta_p = (1)(1.13) = 1.13$$

$$\frac{H_c}{b_c} = \frac{31.5}{2.75} = 11.45$$

$$2K_\mu \frac{H_c}{b_c} = 0.38(11.45) = 4.35$$

$$2K_\mu \delta_p = 0.38(1.13) = 0.43$$

ES-118 $2K_\mu C_p = 9.15$ $C_p = 24.08$

ES-120 $X_p = 0.65$

ES-121 $T = 7.6'$

$$F_{SR} = C_p X_p - KT = (24.08)(0.65) - (0.4)(7.6) \quad \text{(bedding)}$$

$$F_{sr} = 12.61$$

$$R_{eb} = \frac{(1.33)(\gamma)(F_{sr})(b_c)^2}{1.431}$$

$$R_{eb} = \frac{(1.33)(136)(12.61)(2.75)^2}{1.431} = \underline{12,054\ \#/ft}$$

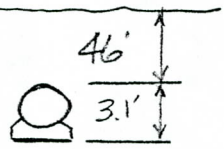
AZ — Harquahala Valley WPP - HARQ. FRS

SMC — 4-24-80 R.A.P. — 4/25/80

Pipe loading LC#2 — Outlet#2 — 2 — 3

Drain Outlet

TR-5
ES-113




assume: $b_c = 2.75$ ft. $H_c = 46'$

$\gamma_m(20') = 130$ pcf $\gamma_s(26') = 136$ pcf

Complete projecting
Case a, $\delta = 1$

$K_N$ 0.4 & $K_\mu = 0.19$

ES-114

$\rho = 1.13$ $\delta_p = 1.13$

$\frac{H_c}{b_c} = \frac{46}{2.75} = 16.73$

$2K_\mu H_c/b_c = (16.73)(.38) = 6.36$

$2K_\mu \delta_p = (0.38)(1.13) = 0.43$

ES-118

$2K_\mu C_p = 13.7$ $C_p = 36.05$

ES-120

$X_p = 0.65$ $T = 11.0'$

$F_{sr} = C_p X_p - KT = (36.05)(0.65) - (0.4)(11.0) = 19.03$

$\gamma = \frac{(20)(130) + (26)(136)}{46} = 133.4$ pcf.

$R_{eb} = \frac{(1.33)\,\gamma\, F_{sr}\, b_c^2}{1.431}$

$= \frac{(1.33)(133.4)(19.03)(2.75)^2}{1.431} = 17,843.17$

Check cradle

AZ — Harquahala Valley WPP – HARQ, FRS

SML 4-24-80 R.A.P. 4/25/80

LC#2, Outlet #2 cradle 3 3

TR-5 ES-113 Same situation as LC#2 (2/3) except pipe on cradle

$b_c = 2.75$ ft. $H_c = 46'$ $\gamma_{comp.} = 133.4$ pcf

$H_c/b_c = 16.73$ $K \sim 0.4$ $K_\mu \sim 0.19$ $\delta = 1$ (cased)

ES-114 6.5

$e b_c = (2.75 \div 2) + 1.92 = 3.3$ ft.

$e = \frac{e b_c}{b_c} = \frac{3.3}{2.75} = 1.20 \therefore \delta_p = 1.2$

$2K_\mu H_c/b_c = 6.36$

$2K_\mu \delta_p = (0.38)(1.2) = 0.46$

ES-118 $2K_\mu C_p = 14.0$ $C_p = 36.84$

ES-120 $X_p = 0.4$ ES-121 $T = 11.0$

$F_{sr} = C_p X_p - KT = (36.84)(0.4) - (0.4)(11) = 10.34$

$$R_{eb} = \frac{1.33 \gamma F_{sr} b_c^2}{1.431}$$

$$= \frac{(1.33)(133.4)(10.34)(2.75)^2}{1.431}$$

$= 9695.1$ #/ft. use $R_{eb}$ 10,000 #/ft.

C301 .001 crack -

AZ
SMC 6-25-80

Harquahala Valley WPP- HARQ. FRS

Drain Outlet pipe joints

| Joint | Δ elev. | slope % | Δ s | invert elev. / length | 1 elev. | 2 station |
|---|---|---|---|---|---|---|
| 1 | | | — | | 1381.47 | 8+90.45 |
| | .9537 | 6.0 | | 15.8941 | | |
| 2 | | | 0 | | 1380.52 | 9+06.34 |
| 3 | | | | | 1379.56 | 9+22.36 (24) |
| 4 | | | | | 1378.61 | 9+38.13 |
| 5 | | | | | 1377.66 | 9+54.02 (03) |
| 6 | | | | | 1376.70 | 9+69.91 |
| 7 | | | | | 1375.75 | 9+85.80 (81) |
| 8 | | | | | 1374.79 | 10+01.69 (71) |
| 9 | | | | | 1373.84 | 10+17.58 (60) |
| 10 | | | | | 1372.89 | 10+33.48 (50) |
| 11 | | | | | 1371.93 | 10+49.37 (39) |
| 12 | | | | | 1370.98 | 10+65.26 (29) |
| 13 | | | | | 1370.03 | 10+81.15 (18) |
| 14 | | | | | 1369.07 | 10+97.04 (07) |
| 15 | | | | | 1368.12 | 11+12.93 (97) |
| 16 | | | 0 | | 1367.16 | 11+28.82 (76) |
| | .9537 | 6.0 | | 15.8941 | | |
| 17 | | | | | 1366.21 | 11+44.72 (76) |

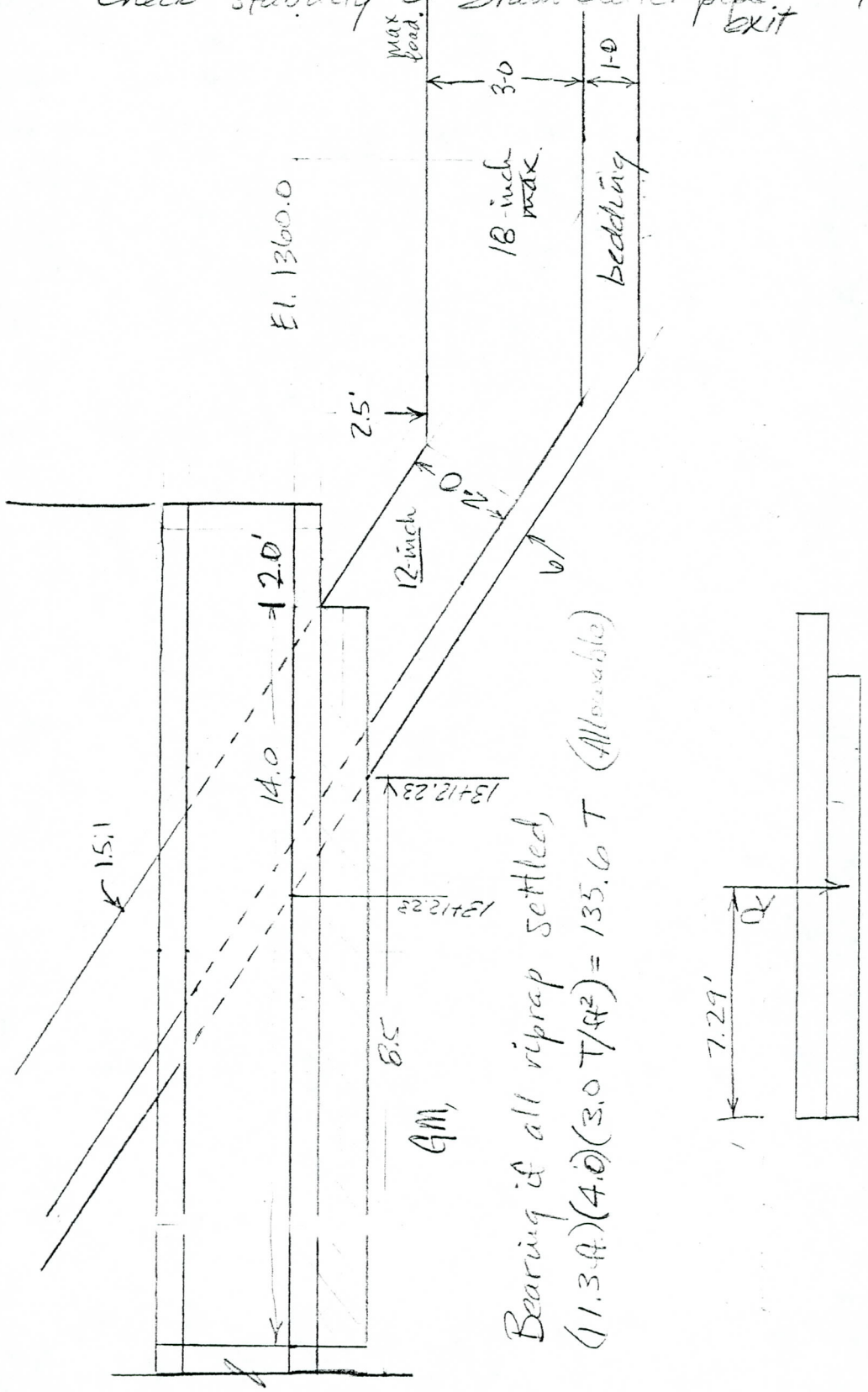
AZ Harquahala Valley WPP – HARQ.FRS
8mc 6-25-80
Drain Outlet pipe joints 2 2

| Joint | Δ elev. | slope% | Δs% | length | elev. | station |
|---|---|---|---|---|---|---|
| 17 | | | | | 1366.21 | 11+44.72 |
| | .9537 | 6.0 | | 15.8941 | | |
| 18 | ↓ | ↓ | 0 | | 1365.26 | 11+60.61 |
| 19 | ↓ | ↓ | 0 | ↓ | 1364.30 | 11+76.50 |
| | .9537 | 6.0 | | 15.8941 | | |
| 20 | | | 0.5 | | 1363.35 | 11+92.39 |
| | 0.87 | 5.5 | | 15.90 | | |
| 21 | | | 0.5 | | 1362.48 | 12+08.29 |
| | 0.80 | 5.0 | | 15.90 | | |
| 22 | | | 1.0 | | 1361.68 | 12+24.19 |
| | 0.64 | 4.0 | | 15.91 | | |
| 23 | | | 1.0 | | 1361.04 | 12+40.10 |
| | 0.48 | 3.0 | | 15.91 | | |
| 24 | | | 1.0 | | 1360.56 | 12+56.01 |
| | 0.32 | 2.0 | | 15.92 | | |
| 25 | | | 1.0 | | 1360.24 | 12+71.93 |
| | 0.16 | 1.0 | | 15.92 | | |
| 26 | | | 0.5 | | 1360.08 | 12+87.85 |
| | 0.08 | 0.5 | | 15.92 | | |
| 27 | | | 0.5 | | 1360.0 | 13+03.77 |
| | 0 | 0 | | 15.92 | | |
| END | | | | | 1360.0 | 13+19.69 |

AZ
SMC 7-24-90

Harquahala Valley WPP- HARQ.FRS

Check Stability of Drain Outlet pipe 1 2




Bearing at all riprap settled,
$(11.3\text{-ft.})(4.0)(3.0\ T/ft^2) = 135.6\ T$ (Allowable)

AZ Harquahala Valley WPP - HARQ.FRS

SMW 7-24-80

Check Stability of Drain Outlet pipe exit 2 2

$\Sigma M_y$ down

16 ft (265#/ft approx) = 4,240# (8) = 33,920 ft#

14 ft (0.186 C.Y./ft)(4050#/cy) = 10,546.2# (7) = 73,823.4 ft#

14,786.2# 107,743.4

$\frac{107,743.4 \text{ ft\#}}{14,786.2\#} = 7.29$ ft. centroid

bearing surface is bottom of cradle.

assume riprap undermined & GM base is left, therefore base length is 10.8 ft. long and resultant acts 7.29/10.8 = 0.675 from left, outside middle 1/3rd. (nearly on).

y = 3.51 ft. b = 4.0 ft. P = 14,786.2#

$f_1 = \frac{2P}{3yb} = \frac{2(14,786.2)}{3(3.51)(4.0)} = 702.1 \#/ft^2$

Allowable soil bearing values

Soil Mechanics in Engineering Practice, Terzaghi & Peck | 1948 | pg. 419

firm coarse sand 3-6 T/ft²

gravel & coarse sand in thick beds 5-8 T/ft²

$\frac{3(2000)}{702.1} = \frac{P_{all.}}{P_{act.}} = S.F. = 8.5$

Safe without pipe support.

AZ Harquahala Valley WPP - HARQ.FRS
SML 5-8-80 R.A.P. 6-5-80

Inverted Plunge Pool Dimensions 1 4

Drain Outlet — "Submerged Pipe Outlet Drain"

Fig. 1 Select $D_{95} = 3''$ SF=2, $\therefore V_{max_x} = 4.3$ fps

use em. spwy. hydro. peak H=38.8 ft Q=56.5 $V_o = 18.00$

Fig. 2 $\frac{V_{max_x}}{V_o} = \frac{4.3}{18} = 0.239$ $\frac{x}{D_o} = 25.5$

$x = (2)(25.5) = 51$ ft.

try $x = 6.2 D_o = 12.4$ ft. $V_{max} = V_o = 18$ fps

Fig 3 $r/x = 0.137$ $r = 0.137(12.4) = 1.70$ ft.

Figs. 2&3 try $x = 24$ ft. $\frac{x}{D_o} = \frac{24}{2} = 12$

$\frac{V_{max}}{V_o} = 0.515$ $V_{max} = 9.27$ $\frac{V_x}{V_{max}} = \frac{4.3}{9.27} = 0.464$ $r/x = .098$

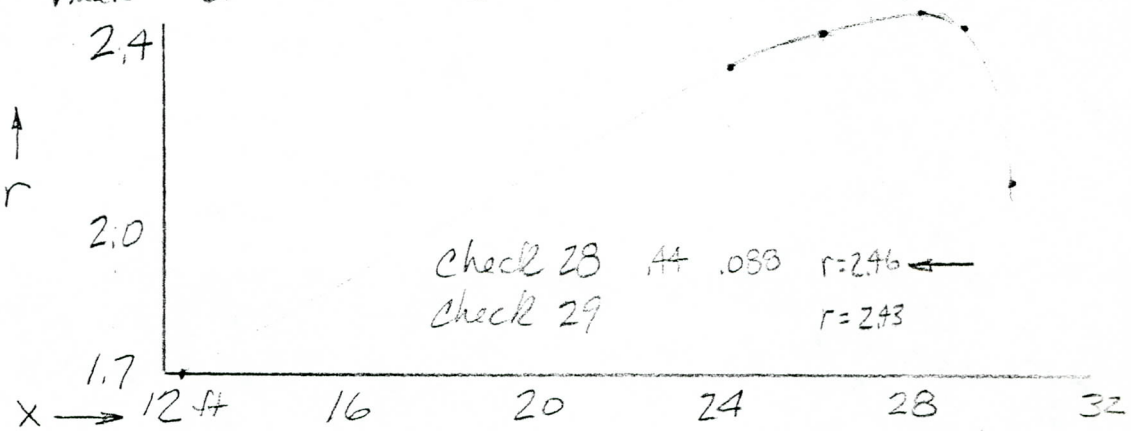
$r = 0.098(24) = 2.35$ ft.

try $x = 30$ ft $\frac{x}{D_o} = 15$ $\frac{V_{max}}{V_o} = 0.41$ $V_{max} = 7.38$

$\frac{V_x}{V_{max}} = \frac{4.3}{7.38} = 0.583$ $\frac{r}{x} = 0.07$ $r = (30)(0.07) = 2.10$ ft.

try $x = 26$ ft. $\frac{x}{D_o} = 13$ $\frac{V_{max}}{V_o} = 0.475$ $V_{max} = 8.55$

$\frac{V_x}{V_{max}} = \frac{4.3}{8.55} = 0.503$ $\frac{r}{x} = 0.093$ $r = 0.093(26) = 2.41$ ft.




29 14.5 .42 7.56 0.583 .083 2.43

AZ Harquahala Valley WPP - HARQ.FRS
SMC 5-8-80 6-5-80
Inverted Plunge Pool - Drain Outlet 2 4

Use $r = 2.5$ ft. $2r + D_o = 7.0$ ft. (bw)

Select $D_{75} = 9"$ $SF = 2$ $\therefore V_{max_x} = 7.5$ fps

$V_o = 18$ fps $\frac{V_{max_x}}{V_o} = \frac{7.5}{18} = 0.42$, $\frac{x}{D_o} = 14.5$

$x = (2)(14.5) = 29$ ft.

find r, $x = 6.2 D_o = 12.4$ ft. $V_x = V_o = 18$ fps

$\frac{V_{max} = 7.5}{V_x = 18} = .42$ $\frac{r}{x} = 0.1045$ $r = 1.30$ ft.

try $x = 20$ ft. $\frac{x}{D_o} = 10$ $\frac{V_{max}}{V_o} = 0.62$ $V_{max} = 11.16$

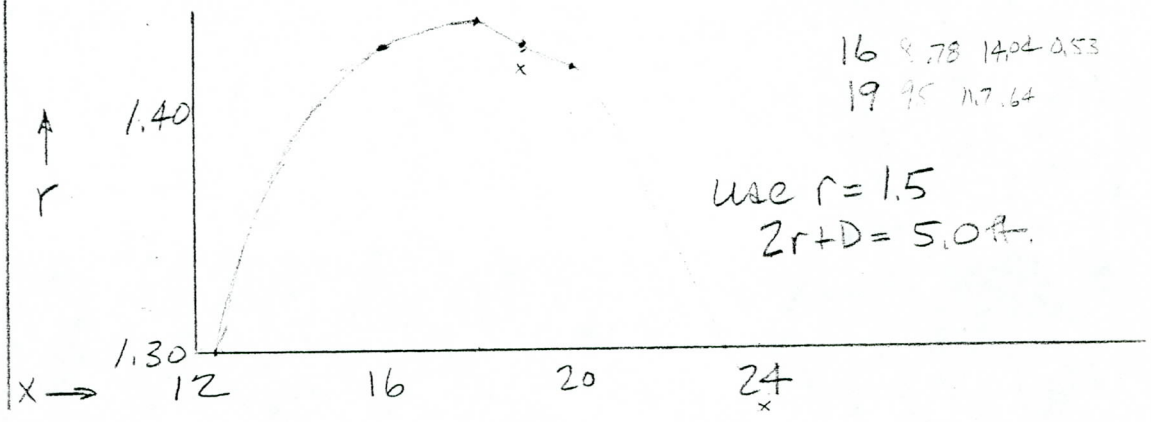
$\frac{V_{max_x}}{V_{max}} = \frac{7.5}{11.16} = 0.672$ $\frac{r}{x} = 0.071$ $r = 1.42$ ft.

try $x = 24$ ft. $\frac{x}{D_o} = 12$ $\frac{V_{max}}{V_o} = 0.515$ $V_{max} = 9.27$

$\frac{7.5}{9.27} = 0.809$ $\frac{r}{x} = 0.053$ $r = 1.27$ ft.

try $x = 18$ $\frac{x}{D_o} = 9$ $\frac{V_{max}}{V_o} = 0.69$ $V_{max} = 12.42$

$\frac{7.5}{12.42} = 0.604$ $\frac{r}{x} = 0.08$ $r = 1.44$ ft.




16 9.78 14.04 0.53
19 9.5 11.7 .64

use $r = 1.5$
$2r + D = 5.0$ ft.

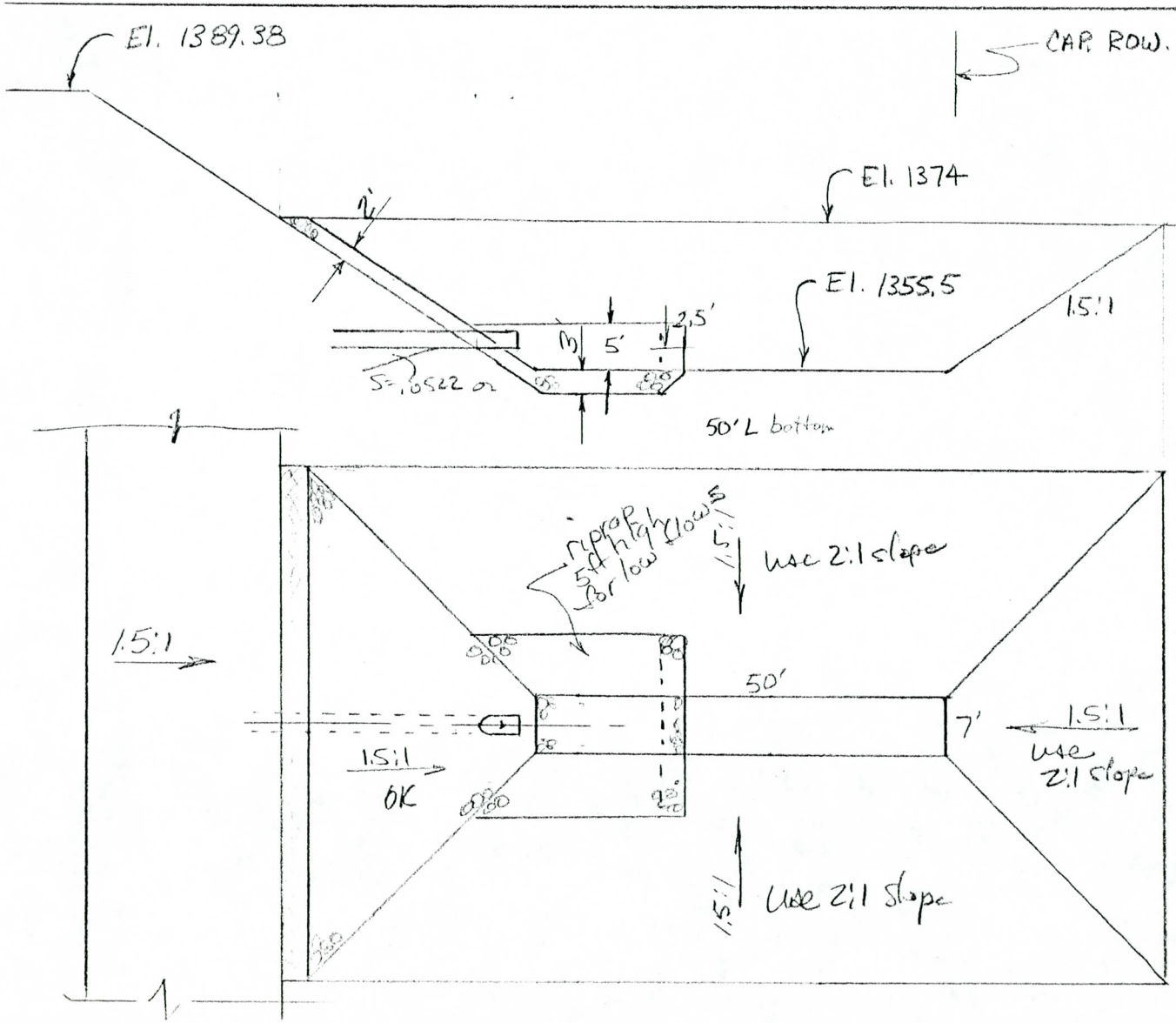
AZ Sinu

5-9-80

Harquahala Valley WPP - HARQ. FRS

R.A.P.

6-5-80




Vbdoo invert

$= \left(T+B+4M\right)\frac{d}{6}$

$\frac{2.5}{6}\left[(7)(50)+(14.5)(57.5)+(4)(10.75)(53.75)\right]$

= 1456.25 Cubic feet

5-20-78

enlarge to 50' x 10' bottom

4 4

270 of 335

United States Department of Agriculture
Soil Conservation Service

River Basin-Watershed Planning Staff
Suite 326, Arizona Title Building
111 West Monroe Street
Phoenix, Arizona 85003

SUBJECT: Addendum to Geologic Investigation Report
Harquahala FRS

DATE: May 15, 1980

TO: Ralph Arrington, SCE

This addendum is in response to a request to determine the amount of sediment delivered to the vegetative outlet at Station 746+00. The average annual sediment yield from the drainage area immediately above this station was estimated to be 0.06 acre-feet or 2614 cubic feet. It can be assumed that this amount of sediment will pass through the pipe outlet. For design purposes 50 percent of this sediment can be considered sand-size material which may be deposited at the pipe outlet.

The drainage area to the west of the vegetative outlet was estimated to have an average annual sediment yield of 0.3 acre-feet or 13,068 cubic feet. It is estimated that 50 percent of this sediment will be sand-size material of which an estimated 10 percent could be transported to the pipe outlet.

To summarize: The estimated yield of sand to the outlet will be 1307 cubic feet from the immediate area plus 653 cubic feet from the area to the west. Total storage required for this sand will be 1960 cubic feet on an average annual basis.

It should be remembered that this figure represents sand-size material only. Fines are expected to be transported away from the outlet. Also, this is an average annual yield which may or may not be delivered in any given year and which will most likely be exceeded only by a 5 to 10 year storm.

Paul F. Pedone
Geologist

cc: T. Niles Glasgow, RBWP Staff Leader

AZ Harquahala Valley WPP- HARQ.FRS

8ML 5-20-80 R.A.P. 6-5-80

Dimensions of Inv. Plunge Pool

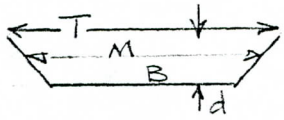
Volume of storage required below pipe invert = 1960 cubic feet.

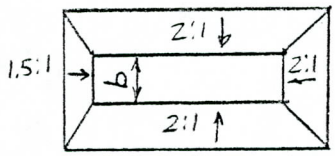
length of bottom = 50 ft.

$V=(T+B+4M)\frac{d}{6}$

depth is 2.5 ft.
SS = 2:1 & 1.5:1 (inlet end)

area @




$B = 50\,b$

$M = (50+2.5+1.875)(b+5)$
$= 54.375\,b + 271.875$

$T = (50+5+3.75)(b+10)$
$= 58.75\,b + 587.50$

$V = 1960$ ft

$$1960 = \left[58.75b + 587.5 + 50b + 4(54.375b + 271.875)\right]\frac{2.5}{6}$$

$$1960 = (1675.0 + 326.25b)\,0.41 = 686.75 + 135.9375b$$

$$b = \frac{1273.25}{135.9375} = 9.366 \text{ ft.}$$ use 10 ft.

$$1960 < \left[587.5 + 587.5 + 500 + 4(543.75 + 271.875)\right]\frac{2.5}{6}$$

$1960 < 2057.3$ yes, OK.

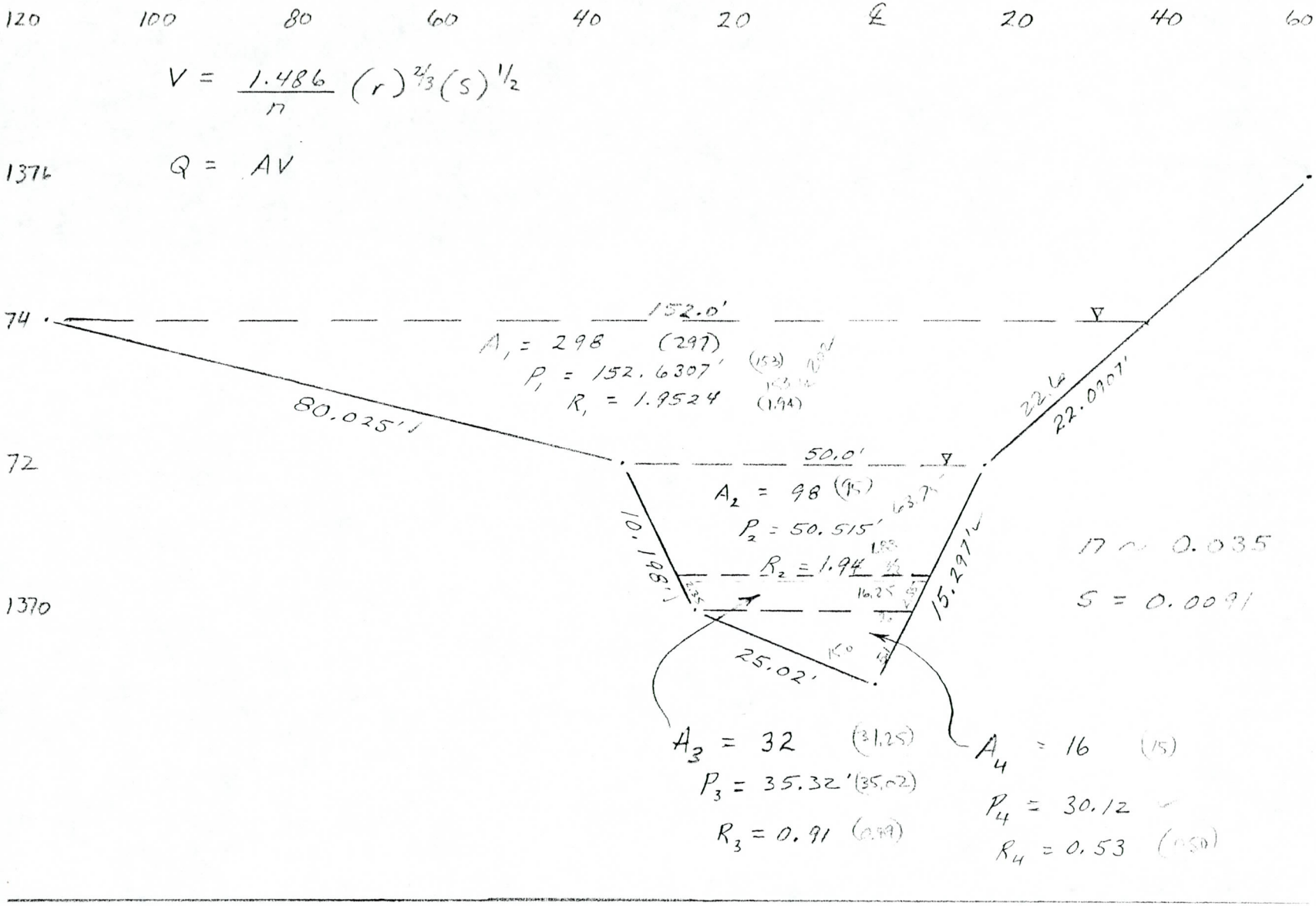
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

COMPUTATION SHEET
SCS-ENG-523 Rev. 8-69

STATE Arizona | PROJECT Floriwahala Valley WPO - Virginia to FRS
Y R.A.P. | DATE 5-1-80 | CHECKED BY [illegible] | DATE 5-5-80 | JOB NO.
SUBJECT Channel Cross-section below St 743+00 | SHEET 1 OF 3

$$V = \frac{1.486}{n}(r)^{2/3}(s)^{1/2}$$

$$Q = AV$$




Note:
Slope calculated from contour 1370, 140' upstream to contour 1368, downstream

SCALE:
1" = 2' Vertical
1" = 20' Horizontal

| STATE | | PROJECT | | |
|---|---|---|---|---|
| Arizona | | Harquahala Valley WPP - Harquahala FRS | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. |
| R.A.P. | 5-5-80 | [illegible] | 5-5-80 | |
| SUBJECT | | | | SHEET 2 OF 3 |
| Velocity and Q Calculations | | | | |

Natural Channel DS. from Drain Outlet, normal flow

Given: $n \sim 0.035$, $S = 0.0091$

Find: Most suitable V & Q

$$V = \frac{1.486}{n} (r)^{2/3} (S)^{1/2}, \quad Q = AV$$

Situation #1: $A_1 = 293$
$P_1 = 152.63'$
$R_1 = 1.95$

$$V = \frac{1.486}{0.035} (1.95)^{2/3} (0.0091)^{1/2}$$

$$V = (42.4571)(1.562)(0.0954)$$

$V = 6.33$ ft/sec

$Q = (293)(6.33)$

$Q = 1886.34$

Situation #2: $A_2 = 98$
$P_2 = 50.515'$
$R_2 = 1.94$

$$V = \frac{1.486}{0.035} (1.94)^{2/3} (0.0091)^{1/2}$$

$$V = (42.4571)(1.555)(0.0954)$$

$V = 6.30$ ft/sec.

$Q = (98)(6.3)$

$Q = 617.4$

(R = 1.88, Q = 586)

| STATE | | PROJECT | | |
|---|---|---|---|---|
| Arizona | | Havasuchala Valley W.PP - Havasuchala FRS | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. |
| R.A.P. | 5-5-30 | [illegible] | 5-5-80 | |
| SUBJECT | | | | SHEET 3 OF 3 |
| Velocity and Q Calculations | | | | |

Situation #3 : $A_3 = 32$
$P_3 = 35.32$
$R_3 = 0.91$

$V = \frac{1.486}{0.035} (0.91)^{2/3} (0.009)^{1/2}$

$V = (42.4571)(0.9391)(0.0954)$

$V = 3.79$ ft/sec.

$Q = (32)(3.79)$

$Q = 121.4$

(R=0.89, Q= 112.14)

Situation #4 : $A_4 = 16$
$P_4 = 30.12$
$R_4 = 0.53$

$V = \frac{1.486}{0.035} (0.53)^{2/3} (0.0091)^{1/2}$

$V = (42.4571)(0.6549)(0.0954)$

$V = 2.66$ ft/sec.

$Q = (16)(2.66)$

$Q = 42.5$

(R=.50, Q= 38.27)

peak flow from Drain Outlet will be <50 cfs (Freeboard Hydrograph, gate open would be 64cfs, but that should not be possible with good management) The natural channel will handle this discharge and be stable.

NEW TANK OUTLET

AZ
SMC 5-20-80 Harquahala Valley WPP - HARQ.FRS
R.I.P. 6-5-80

New Tank Outlet

The elevation of the New Tank Outlet entrance is above the elevation of the principal spillway crest. If a gate is installed, as proposed, it will have to be left open to collect as much water as possible for the stockwater tank. The purpose of the gate is to permit BLM to detain further runoff if New Tank is full, or for any other management reason. The outlet elevation is as low as possible to receive runoff from small storms. A collection channel has been designed to increase the watershed available to the New Tank Outlet.

Although very little sediment is expected at this outlet due to its elevation and physical position on a flat ridge, it is three feet below the projected sediment pool elevation for this location. Some maintenance will be required to keep the New Tank Outlet working most efficiently. The type of storm will determine the location of sediment, upstream or downstream of the outlet conduit.

Any outlet from the dam has the option of discharging water 1) into the CAP, 2) between the CAP canal and the dam, 3) over the top of the CAP canal, or 4) under the invert of the CAP canal. Since

AZ Harquahala Valley WPP - HARQ. FRS

SML 5-20-80

New Tank Outlet - cont.

The New Tank Outlet water is intended to keep New Tank reservoir full of livestock water, the first two options are not suitable. The third option does not permit much flexibility in elevation location of the inlet on the upstream side of the dam and requires some form of energy dissipator at the downstream side of the CAP canal. The fourth option requires a siphon, which makes sediment a potential hazard within the pipe, or a very large excavation downstream from the CAP canal (29.5 feet deep). The third option has been selected.

The New Tank Outlet will have a standard (TR-46-type) slide gate entrance structure, 24-inch prestressed concrete cyl. pipe with cradle and collars, steel pipe over the CAP canal on one R/C pier (similar to other pipe overchutes in CAP design), and a standard impact basin energy dissipater.

Since the impact basin does not require tailwater to function efficiently, overland flow will be permitted to the New Tank reservoir. The outlet has been located where present drainage flows to the reservoir. A very short channel is required.

AZ — Harquahala Valley WPP - HARQ-FRS

SML 4-25-80 R.A.P. 4/23/80

Veg. Outlet #1, peak discharge (New Tank) 2 2

$H = 1408.4 - 1391 = 17.4$ ft., say 18 ft.
(assume same as sheet 1 of 2, em. spwy. crest elev.)

$L = 175$ ft. $D = 24"$ $n \approx 0.013$ full pipe

$C = 0.36$

$Q = CA\sqrt{2gh}$

$= (0.36)(3.14)[(64.4)(18)]^{1/2} = 38.5$ cfs

$V = \frac{38.5}{3.14} = 12.3$ fps.

Check Qp @ Principal Spillway Elev.

Principal Spillway Crest is below this outlet elevation.

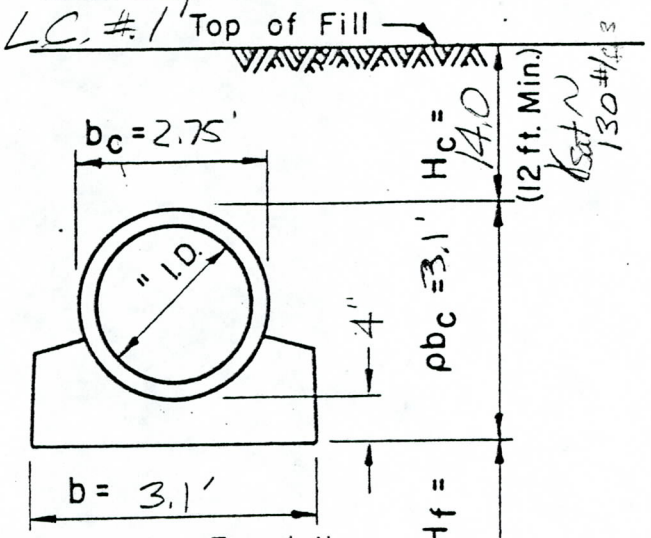
Check top of dam - $H = 1420.6 - 1391 = 29.6$ ft.

$[(29.6)(64.4)]^{1/2}(0.36)(3.14) = 49.4$ cfs ←

BY SWW DATE 4-22-80 SUBJECT " DIAM. R/C PIPE STRENGTH FOR STR. SHEET NO. 279 OF 335 2

CHKD. BY RAP DATE 4/25/80 JOB NO. Harquahala FRS

Veg Outlet #1 Sta 583+75.52, New Tank 0




Reference: Technical Release No. 5

Assumptions See E.S.-113/1

1. Case "C" Exists (Yielding Foundations)
2. $\delta \approx$ 0.5 Homogenous Fill and Foundation Material
3. Positive Projecting - Incomplete Condition $\frac{H_c}{b_c} > \frac{H'_e}{b_c}$

From Soil Lab Report and E.S.-114/3

assume $\gamma_{sat} \approx$ 130 lb/ft.³ $\phi$ = _____

K = _____ $\mu$ = _____

$K\mu$ = 0.19 (0.19 Max.) $2K\mu$ = 0.38

$\rho = \frac{\rho b_c}{b_c} = \frac{(3.1)}{(2.75)} =$ 1.13

$\delta\rho = (0.5)(1.13) =$ 0.56

$\frac{H_c}{b_c} = \frac{(14)}{(2.75)} =$ 5.09

$2K\mu \frac{H_c}{b_c} = (0.38)(5.09) =$ 1.93

$2K\mu\delta\rho = (0.38)(0.56) =$ 0.21

Drwg. E.S.-118/2 or 3

$2K\mu C_p =$ 3.2

$C_p = \frac{(3.2)}{(0.38)} =$ 8.42

Load Coefficient - Positive Projecting Conduits

Drwg. E.S.-120/2 or 3

$X_p =$ 0.65

Distribution - Vertical Load and Reaction

Drwg. E.S.-121/1 or 2

T = 3.58

Parameter - Active Lateral Earth Pressure

$F_{sr} = C_p X_p - KT$ (most conserv.)

$= (8.42)(0.65) - (0.4)(3.58)$

$= (\quad) - (\quad)$

$=$ 4.04

Required Strength Factor

Safety Factor

($s_1$) For 0.001" Crack = 1.00

($s_2$) For 0.01" Crack = 1.33

$R_{eb} = \frac{(s_1)(\gamma)(F_{sr})(b_c)^2}{1.431}$

$= \frac{(1.00)(130)(4.04)(2.75)^2}{1.431}$

Three-Edge Bearing Strength

$R_{eb} =$ 2775.6 For 0.001" Crack

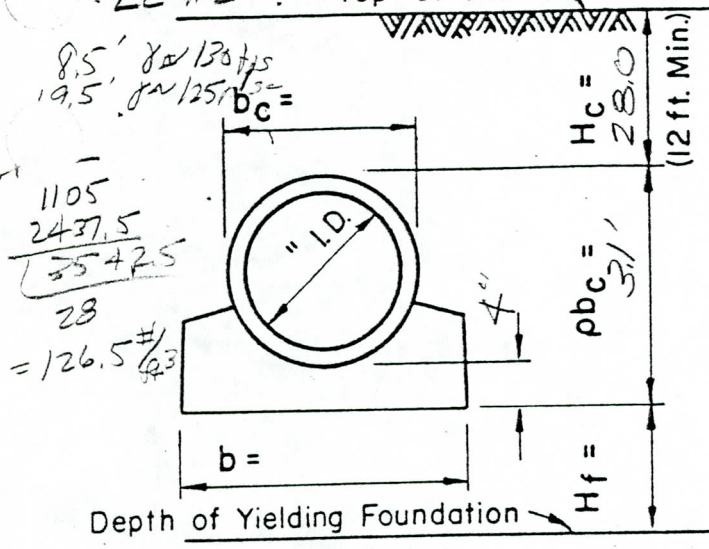
$R_{eb}(s_2) = (2775.6)(1.33) =$ 3691.5

For 0.01" Crack Bedding

STR.

DWG NO. 3-1-46209

LC #2 . Top of Fill




1105
2437.5
3542.5
28
= 126.5 #/ft³

Depth of Yielding Foundation

Reference: Technical Release No. 5

Assumptions See E.S.-113/1

1. Case "C" Exists (Yielding Foundations)
2. δ ≈ 0.5 Homogenous Fill and Foundation Material
3. Positive Projecting - Incomplete Condition $\frac{H_c}{b_c} > \frac{H'_e}{b_c}$

From Soil Lab Report and E.S.-114/3

$\gamma$ = 126.5 lb/ft.³ $\phi$ = _____

K = ≈ 0.4 conserv. $\mu$ = _____

K$\mu$ = 0.19 (0.19 Max.) 2K$\mu$ = 0.38

$\rho = \frac{\rho b_c}{b_c} = \frac{(\ 3.1\ )}{(\ 2.75\ )} =$ 1.13'

$\delta\rho = (1.13)(0.5) =$ 0.56'

$\frac{H_c}{b_c} = \frac{(\ 28\ )}{(\ 2.75\ )} =$ 10.18

$2K\mu \frac{H_c}{b_c} = (0.38)(10.18) =$ 3.87

$2K\mu\delta\rho = (0.38)(0.56) =$ 0.21

DWG. NO. 3-L-46209

Drwg. E.S.-118/2 or 3

$2K\mu C_p$ = 6.7

$C_p = \frac{(\ 6.7\ )}{(\ 0.38\ )} =$ 17.63'

Load Coefficient - Positive Projecting Conduits

Drwg. E.S.-120/2 or 3

$X_p$ = 0.65

Distribution - Vertical Load and Reaction

Drwg. E.S.-121/1 or 2

T = 6.8

Parameter - Active Lateral Earth Pressure

$F_{sr} = C_p X_p - KT$
$= (17.63)(0.65) - (0.4)(6.8)$
$= (\quad) - (\quad)$
$=$ 8.74

Required Strength Factor

Safety Factor

($s_1$) For 0.001" Crack = 1.00

($s_2$) For 0.01" Crack = 1.33

$R_{eb} = \frac{(\ s_1\ )(\ \gamma\ )(\ F_{sr}\ )(\ b_c\ )^2}{1.431}$

$= \frac{(1.00)(126.5)(8.74)(2.75)^2}{1.431}$

Three-Edge Bearing Strength

$R_{eb}$ = 5,842.99 For 0.001" Crack

$R_{eb}(s_2) = (8361.2)(1.33) =$ 7,771. For 0.01" Crack bedding

STR.

AZ
SMC

Harquahala Valley WPP- HARQ. FRS

6-17-80
Settlement at New Tank
for pipe camber

Settlement expected at Sta. 583+80, New Tank Outlet.

1.4 ft of found. set. has been calculated at Sta. 522+50
1.8 ft of foundation settlement has been calculated at Sta. 603+00

In spite of Sta 583+80 being closer to the analyzed section at Sta. 603+00, the material in the foundation appears more closely related to that at Sta. 522+50. I would recommend 1.4 ft. for camber of the pipe at Sta. 583+80.

P.V.M. 6-18-80

AZ
SMK 6-18-80 Harquahala Valley WPA HA20.FRS

Camber, 1.4 ft, New Tank Outlet

Sta 583+80

| Joint | Elev. | Δ Elev. | Slope (%) | Δ S (%) | H dist. | Station |
|---|---|---|---|---|---|---|
| 1 | 1394.09 | | | | | 9+22.20 |
| | | 0 | 0 | | 15.92 | |
| 2 | 1394.09 | | | .56 | | 9+38.12 |
| | | 0.09 | .56 | | 15.92 | |
| 3 | 1394.00 | | | .26 | | 9+54.04 |
| | | 0.13 | .82 | | 15.92 | |
| 4 | 1393.87 | | | .25 | | 9+69.96 |
| | | 0.17 | 1.07 | | 15.92 | |
| 5 | 1393.60 | | | 1.44 | | 9+85.88 |
| | | 0.40 | 2.51 | | 15.91 | |
| 6 | 1393.20 | | | 0.76 | | 10+01.79 |
| | | 0.52 | 3.27 | | 15.91 | |
| 7 | 1392.68 | | | 1.00 | | 10+17.70 |
| | | 0.68 | 4.27 | | 15.91 | |
| 8 | 1392.00 | | | 0.88 | | 10+33.61 |
| | | 0.82 | 5.15 | | 15.90 | |
| 9 | 1391.18 | | | 0.30 | | 10+49.51 |
| | | 0.87 | 5.45 | | 15.90 | |
| 10 | 1390.31 | | | 3.50 | | 10+65.41 |
| | | 0.31 | 1.95 | | 15.92 | |
| 11 | 1390.00 | | | 1.76 | | 10+81.33 |
| | | 0.03 | 0.19 | | 15.92 | |
| 12 | 1389.97 | | | 0 | | 10+97.25 |
| | | 0.03 | 0.19 | | 15.92 | |
| 13 | 1389.94 | | | 0 | | 11+13.17 |
| | | 0.03 | 0.19 | | 15.92 | |
| 14 | 1389.91 | | | 0 | | 11+29.09 |
| | | 0.03 | 0.19 | | 15.92 | |
| 15 | 1389.88 | | | | | 11+45.01 |

Joint to steel pipe, 24-inch O.D., 0.375" thick.

14 lengths R/C pipe, 16-foot nominal length (or 28, 8-ft)
123.54 min. length steel pipe.

AZ Harquahala Valley WPP - HARQ.FRS
SML 5-23-80 W.E.P. 6-5-80
Steel Allowable Stresses 1 2
New Tank Outlet

Note:

NEH-6 refers to AASHO
Standard Specifications for Highway Bridges 1949

Our only copy, same name, is 1957 edition.

Section 4, unit stresses, shows

Pg. 30-32
$E = 29,000,000$ psi, coef. of expansion
$C_e = 0.0000065$ per °F
$f_t = 18,000$ psi.
$f_c = 18,000$ psi.

The Manual of Steel Construction (AISC)
in this office is 1963, 6th ed.

Pg 5-57
$F_y = 33,000$ psi
$f_t = 20,000$ psi.
$f_v = 13,000$ psi.
$f_b = 22,000$ psi Compact section (bend)
$20,000$ psi others
$f_p = 30,000$ psi. (bearing)

Pg. 5-67
$F_y = 36,000$ psi
$f_t = 22,000$ psi
$f_v = 14,500$ psi
$f_b = 24,000$ psi.
$f_p = 33,000$ psi.

AZ
EMC

Harquahala Valley WPP- HARQ.FRS

5-23-80 W.E.P. 6-5-90

Steel, allowable stresses 2 2

AWWA Manual M11 – 1964 ✓
Steel Pipe Design and Installation

all 24-inch diam. steel pipe sufficient to bear internal pressure of 12.4 psi. (Minimum test pressure 422 psi)

Pg 54

| | 50% yield pt. Design Stress |
|---|---|
| ASTM A 415 | 12,500 psi ✓ |
| ASTM A 283 B | 13,500 psi. ✓ |
| ASTM A 283 C | 15,000 psi ✓ |
| ASTM A 283 D | 16,500 psi. ✓ |

1954 survey, standard design practice 14,800 psi

Our structure will be relatively light duty, but is intended to last 100 years.
Design will be based on ✓ 13,500 psi. design stress.

Grade A, A 53

AZ
SML

Harquahala Valley WPP-HARQ.FRS
5-23-80 W.E.P. 6-4-80
Steel pipe over CAP canal 1 6

The New Tank Outlet requires conveyance of water from Harquahala FRS across the top of the CAP canal to a suitable outlet. The top width of the concrete canal is 79.8 feet. addition of the required 6-inch vertical clearance makes that 81.8 feet. Assume at least 1.0' to abutments for a minimum span of 82.8 feet.
Two spans of 41.4 feet or three spans of 27.6 feet, minimum, are required
Assume: 120 degree Contactangle at all supports; steel pipe; 24-inch OD.; $E = 30 \times 10^6$ psi; $I = 950.21$ to $2549.36$ in$^4$ (Table 9.4, AWWA M11, Steel Pipe Manual); internal maximum pressure of 28.6 ft or 12.4 psi (top of dam).

Check 0.375-inch wall thickness
table 9.3 shows safe span of 43.0 ft.

max. desireable deflection is $\frac{1}{360}(L)$

$\frac{(41.4)(12)}{360} = 1.38$ inch

AWWA M11 Pg. 113

$y = 22.5\frac{WL^3}{EI}$ $W = 291\#/ft.$ $I = 1942.3$ in$^4$

$y = \frac{(22.5)(291)(41.4)^3}{(30{,}000{,}000)(1942.3)} = 0.008$ in $< 1.38$ in.

Pg. 115

required gradient $G = \frac{L}{4y} = \frac{41.4}{4(.008)} = 1"$ in $129\,ft.$

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Harquahala Valley WPP- HARQ.FRS

5-27-80 W.E.P. 6-4-80

Steel pipe over CAP canal 2 6

Find Reactions and check $S_c$ with continuous beam, simply supported. Conservative. Actual pipe will be restrained

Use theorem of three moments and assume end moments are 0, uniform load.

$$M_a\frac{l_1}{I_1} + 2M_b\left(\frac{l_1}{I_1} + \frac{l_2}{I_2}\right) + M_c\frac{l_2}{I_2} = -\frac{1}{4}\left(\frac{w_1 l_1^3}{I_1} + \frac{w_2 l_2^3}{I_2}\right)$$

$M_a = M_c = 0 \quad l_1 = l_2 = 42 \quad I_1 = I_2 = 1942.3$

$$4M_b\left(\frac{l_1}{I_1}\right) = -\frac{1}{2}\left(\frac{w_1 l_1^3}{I_1}\right)$$

$$M_b = -\frac{(w l^3 / I)}{8\frac{l}{I}}$$

$$= -\frac{(291)(42)^3}{(8)(42)} = \underline{-64,165.5 \text{ ft\#}}$$

$$S_c = \frac{Mc}{I} = \frac{(-64,165.5)(12)(12)}{1942.3} = \underline{\underline{4757.16 \text{ psi}}}$$

by trial & error, if $M_b = -64,165.5$ ft#,

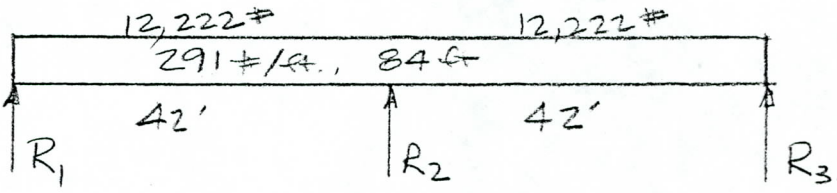
$R_1 = 4583.25\# = R_3$ & $R_2 = 15,277.5\#$

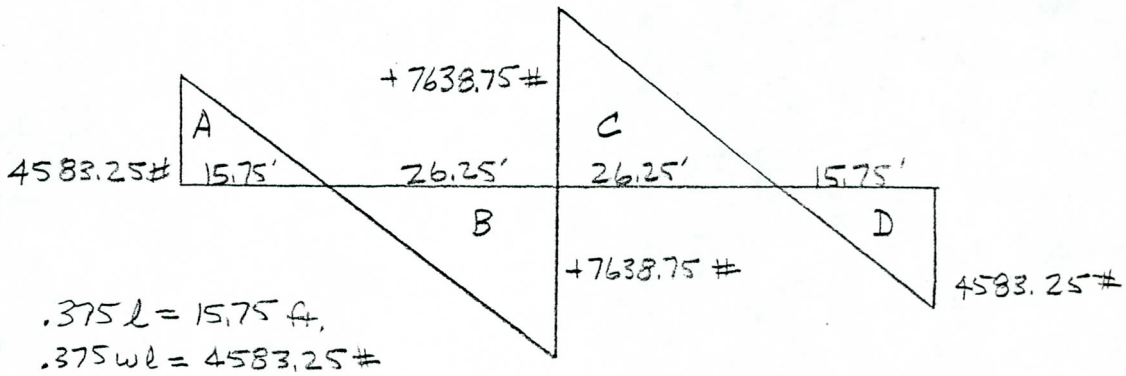
load factor @ $R_1 = 0.375$

AZ Harquahala Valley WPP - HARQ. FRS

SMC 5-30-80 W. E. P. 6-4-80

steel pipe over CAP canal 3 6



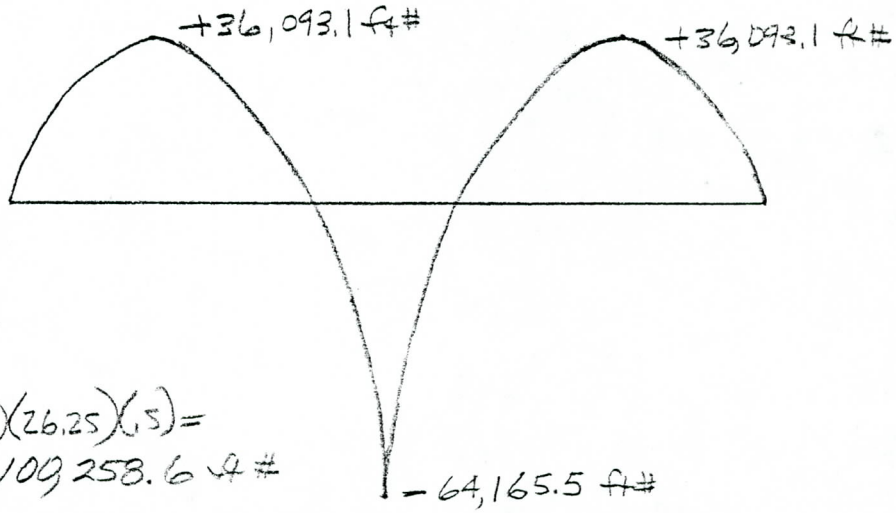

$.375\ell = 15.75$ ft,

$.375w\ell = 4583.25$#

Max. load on column $= 2(7638.75) = 15,277.5$#

use 15,300# column load

$M_A = M_D = (4583.25)(15.75)(.5) = 36,093.1$ ft#




$M_B = M_C =$

$(7638.75)(26.25)(.5) =$

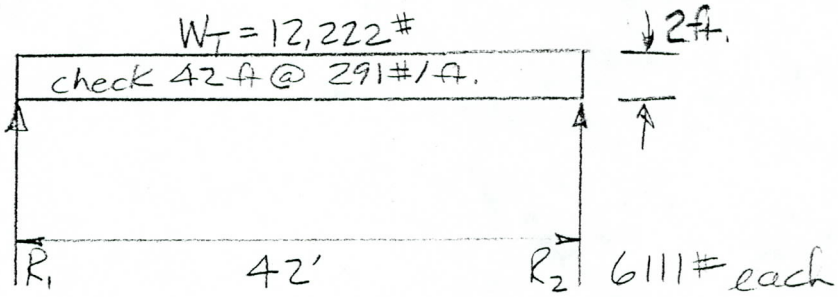
$100,258.6$ ft#

$M_A - M_B = 36,093.1 - 100,258.6 = -64,165.5$ ft#, $M_{max}$

AZ Harquahala Valley WPP-HARQ.FRS
SML 5-27-80 W.E.P. 6-4-80
steel pipe over CAP canal 4 6

Check all stresses, 0.375-inch thick steel pipe, 24-inch diameter

Assume simple beam,




$M = \frac{WL}{8} = \frac{(12,222)(42)}{8} = 64,165.5$ ft#

from flexure formula, $M = S_f \frac{I}{c}$

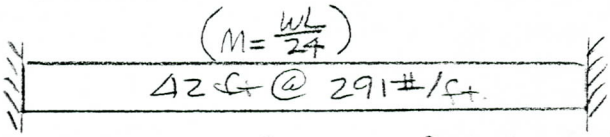
$c = 1$ ft. $I = 1942.3$ in$^4$ $M = 64,165.5$ ft#

$S_f = \frac{Mc}{I} = \frac{(64,165.5 \text{ ft\#})(1 \text{ ft})(144)}{1942.3 \text{ in}^4} = 4,757.16$ psi.

$S_f = 4757.16$ psi for 0.375-inch. < 13,500 psi.

Check 0.25-inch, $I = 1315.35$
$S_f = 7,024.62$ psi < 13,500 psi.

$S_f$ = flexure stress




$M = \frac{WL}{12} = \frac{(12,222\#)(42)}{12} = 42,777$ ft.#

$S_f = \frac{(42,777)(144)}{1942.3} = 3,171.4$ psi.

restrained ends

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Harquahala Valley WPP- HARQ.FRS
5-27-80 W.E.P. 6-4-80
Steel pipe over CAP canal 5 6

6th Ed. AISC Man. of Steel Constr. 32.

Use fixed end reaction of $R_1 = \frac{wl}{2}$
to design load @ end supports,
End loads $\approx \frac{wl}{2} = \underline{6111\ \#}$

$S_p$ = ring stress due to internal pressure

$= \frac{pd}{2t} = \frac{(12.4 psi)(24 in)}{(2)(0.375 in)} = \underline{396.8 psi.}$

Check $S_b$ restrained $= S_t + 0.25 S_p$

$S_b = 3171.4 psi + 0.25(396.8 psi)$

$= 3270.6 psi < S_t$ unrest. $= 4757.2$ psi

use $\underline{S_b = 4758 psi.}$

$S_\ell = K \frac{P}{t^2} \log_e \frac{R}{t}$

$P = 15,300\#$
$R = 12 in.$
$t = 0.375 in.$
$A = 120°$

$K = 0.07 - 0.00012(A-90)$

$K = 0.0164$

$S_\ell = 0.0164 \left(\frac{15300\#}{(0.375)^2}\right)\left(\log_e \frac{12}{0.375}\right) = 6,184$ psi.

$S_t = S_\ell + S_b = 6184 + 4758 = \underline{10,942 psi.}$

$< 13,500 psi.$, OK

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Harquahala Valley WPP- HARQ-FRS

5-27-80 W.E.P. 6-4-80

Steel pipe over CAP Canal 6 6

AWWA M11 pg. 103

Check steel pipe with shallow cover and live load

D = 24 inch, 2% deflection, 3-ft cover
H-20 live load, SM-ML backfill.
assume shape factor F=1.40, $\gamma = 125\ \#/ft^3$

$w_v = w_{vd} + w_{vl}$ = total vert. unit load (psi) (live + dead loads)

Table 8.4 $w_{vd} = 2.60$ psi.

Table 8.5 $w_{vl} \approx 4.1$ psi.

$w_v = 6.7$ psi.

Fig. 8.14 table 8.4 $w_p$ = ring load w/2% defl. ≈ 17 ft. or 14.8 psi. for 0.375-inch wall
check 0.25-inch wall, ≈ 5.0 ft. or 4.34 psi.

$w_h = 1.40(w_v - w_p) = 1.40(6.7 - 14.8) = -11.34$ psi. < 14.8

or $1.40(6.7 - 4.34) = 3.30$ psi. < 4.34

Fig 9.15 check arch load w/ 0.25-inch wall

0.25-inch wall, 24-inch D, H = 170 ft.

either pipe will carry loads on OEM road for CAP. ample.

AZ
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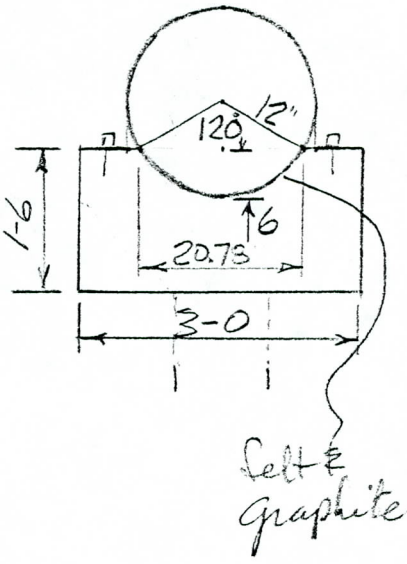
Harquahala Valley WPP - HARQ. FRS

5-27-80 W.E.P. 6-17-80

pipe support New Tank Outlet 1 8

Saddle dimensions 12" thick
3.0 feet wide
1.5 feet deep




$r = 12"$

$\theta = 120°$

$chord = 2r \sin\frac{\theta}{2}$

$= 2(12)\sin\frac{120}{2} = 20.78"$

$\frac{20.78}{2} = 10.39"$

$a = \sqrt{c^2 - b^2} = \sqrt{12^2 - 10.39^2}$

$a = 6.004$ in $\quad 12 - 6 = 6$

Volume of pipe in saddle

$\frac{120}{360}\left(\frac{\pi 1^2}{4}\right)(1') = 0.26\ ft^3$

Volume of concrete saddle

$(1ft)(3ft)(1.5ft) - (0.26^3) = 4.24\ ft^3$

Wt. of saddle + Reaction

$4.24\ ft^3\ (150\#/ft^3) + 15{,}300 = 15{,}936\ \#$

Unit load on 12-inch diam. pier

$\frac{15{,}936}{\frac{\pi(12)^2}{4}} = 141$ psi $\quad$ (Area = $113.1\ in^2$)

use 16,000#

AZ
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Harquahala Valley WPP – HARQ.FRS

5-28-80 W.E.P. 6-17-80

pipe support – Column 2 8

Urquhart, 4th Ed, Civil Engineering Hdbk.

7-146

concentric load of 16,000 #
$f_c' = 4000$ psi, (table uses 3750)
$f_s = 20{,}000$ psi.
$P_g = 0.01$, minimum $A_s/A_g$ ($\frac{18'}{1'} = 18$, $h/t > 10, < 20$)

Smallest column is 12" diameter

| | | |
|---|---|---|
| Concrete | carries | 76,000 # |
| Steel | carries | 18,000 # |
| total | load | 94,000 # |

Sheet 5 See Sheet 5

greatly exceeds 16,000 # needed.

$A_s = 0.01\ (113\ in^2) = 1.13\ in^2$

4 – #5 bars = $1.24\ in^2$

lateral ties, #3 @ 10" or less

Check peak lateral load on column:

hydrostatic load cancels itself (all sides)
velocity/impact load, assume water 17.5' deep, 1'wd.

$F = \frac{\gamma}{g} a V^2$ $V$, <1 fps, use 1.5

$F = (62.4 \div 32.2)(17.5)(1.5)^2 = 76.3$ #

$M = 76.3\ (17.5/2) = 667.7$ ft# (697, V=1)

for flat surface, not hemisphere.

insignificant compared with actual or allowable concentric loads.

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Harquahala Valley WPP - HARQ. FRS.

5-30-80 W.E.A. 6-17-80

pipe support, column 3 8

Notes on ACI 318-77

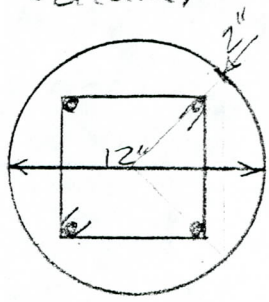
3-47

Compression lap splice for column

$f'_c = 4000$ psi. 12-inch diam.

$f_y = 50{,}000$ psi

4 - #5 bars




$$l_d = 0.02\, d_b\, f_y / \sqrt{f'_c}$$

$d_b$ = bar diameter $5/8" = 0.625"$

$$l_d = 0.02\,(.625)(50{,}000) \div \sqrt{4000} = 9.88 \text{ in.}$$

not less than 12" or $0.0005\, d_b\, f_y$

$0.0005\,(0.625)(20{,}000) = 15{,}625$ in.

NEH-6

SCS criteria, compression splice

24 x bar diam

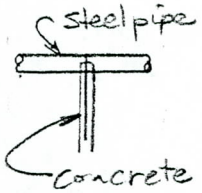
$24\left(\frac{5}{8}\right) = 15$ inches SCS

use <u>16 inch</u> splice

AZ
SWL 6-80
Newtonk – check column effective length

Harquahala Valley WPP- HARQ. FRS

$K = \frac{EI}{\ell}$ $E_s = 29,000,000$ $E_c = 3,640,000$ psi




$I_s = \frac{\pi(D^4 - d_i^4)}{64} = \frac{\pi(24^4 - 23.25^4)}{64}$

$I_s = 1942.3 \text{ in}^4$

$I_c = \frac{\pi d^4}{64} = \frac{\pi(12)^4}{64} = 1018 \text{ in}^4$

$K_s = \frac{(29,000,000)(1942)}{(42)(12)} = 111,742,063.5 \#$

$K_c = \frac{(3,640,000)(1018)}{(18)(12)} = 17,155,185.2 \#$

$r' = \frac{K_c \text{ (column)}}{K_s \text{ (beam)}(2)} = \frac{17,155,185.2}{(111,742,063.5)(2)} = 0.0767$

(restrained at joint)

check stiffness @ base

$r' = \frac{E_c \frac{I_c}{\ell_c}}{E_c\left(\frac{I_f}{\ell_f}\right)2}$ $I_f = \frac{bd^3}{12} = 6048 \text{ in}^4$

$K_f = \frac{1018\ (21)}{(18)(12)(2)(6048)} = 0.0082$

(restrained at joint)

$\bar{r}' = \frac{0.0082 + 0.0767}{2} = 0.0425$

$h'$ = effective length

$h' = h\ [0.78 + 0.22\ \bar{r}']$

$= 18.4\ [0.78 + 0.22(0.0425)] = 14.21$ ft.

AZ
SwL 6-80

Harquahala Valley WPP - HARQ.FRS

Check column allowable axial load

New Tank

R/C column, gross area = 113 in²

4, #5 bars, $A_s$ = 1.24 in²

$f_s$ = 20,000 psi $F_y$ = 50,000 psi.

$f'_c$ = 4000 psi.

$$P_g = \frac{A_s}{A_g} = \frac{1.24}{113} = 0.011$$

$$P_{all.} = 0.85 A_g (0.25 f'_c + f_s p_g)$$

$$P_{all.} = (0.85)(113)[(0.25)(4000) + (20,000)(0.011)]$$

$P_{all.}$ = 117,181 # allowable axial load.

AZ
Suc

Harquahala Valley WPP - HARQFRS
5-31-80 W.E.P. 6-17-80
pipe support, footing 4 8

Column height

18.6 ch.
.5 top
.5 bottom
.25 lining
.20 slope
20.05 ft
-1.00 saddle
19.05 ft

Reaction + wt. of saddle ≃ 16,000#

weight of column

$W \frac{\pi d^2}{4} h = \frac{\pi (1)^2}{4} ft^2 (19.05)(150\#/ft^3) = 2244.3\#$
(14.96 $ft^3$)

16,000 + 2,244.3 = 18,244.3 #

assume square footing.

try 3-6 square w/ 10" depth

block wt = (0.833)(3.5)(3.5)(150) = 1530.6#

1530.6 + 18,244.3 = 19,774.9 use 19,775#

check unit load on soil

$\frac{19,775\#}{(3.5)(3.5)} = 1,614.3\ \#/ft^2$

Parker, Symp. Des. of R/C 3rd Ed pg. 222

Allurial soil, approx. ½ T/$ft^2$ allow. bear.
(assume worst cond.)

present load @ 20 ft depth, assume $\gamma_s$ = 85 #/$ft^3$ (low for area)

(20)(85) = 1700 #/$ft^2$ > 1614.3 #/$ft^2$ OK.

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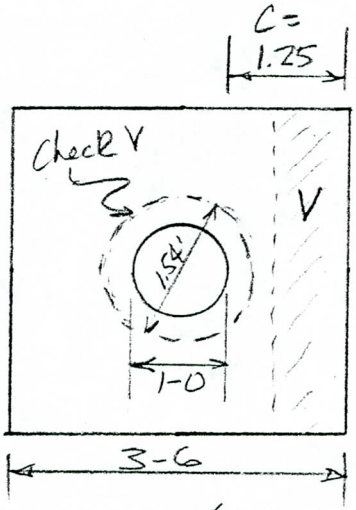
Harquahala Valley WPP - Harq. FRS

5-31-80 W.E.P. 6-17-80

pipe support, footing

5 8




$f'_c = 4000$ psi ($R=324$)
$f_s = 20{,}000$ psi.

Parker pg. 230 & 54

$$M = \frac{wlc^2}{2}$$

$$M = \frac{(1614.3\#/ft^2)(3.5)(1.25)^2}{2}$$

$$M = 4{,}414.1 \text{ ft}\#$$

$$d = \sqrt{\frac{M}{Rb}}$$

$$d = \sqrt{\frac{(4414.1)(12)}{(324)(42")}} = 1.97"$$

much > 10-3.5 = 6.5" = d OK

Shear @ $c - d = 1.25' - \frac{6.5}{12} = 0.71$ ft.

$A = (0.71 ft)(3.5 ft) = 2.485 ft^2$

$V = Aw = (2.485 ft^2)(1614.3 \#/ft^2) = 4{,}011.5 \#$

pg. 62 all.

$$v = \frac{V}{bd} = \frac{4011.5\#}{(42)(6.5)} = 14.7 \text{ psi}, < 70 \text{ psi}.$$

very small.

Shear @ d/2 (periphery)

$\left(\frac{6.5}{12}\right)\left(\frac{1}{2}\right) = 0.27$ ft. $\quad 2(.27) + 1.0 ft = 1.54$ ft.

1.54 ft. = 18.48"

$$V = (1614.3\#/ft^2)\left[(3.5 ft)^2 - \frac{\pi(1.54)^2}{4}\right] = 16{,}768.3\#$$

$$v = \frac{16{,}768.3\#}{\pi(18.48)(6.5)} = 44.4 \text{ psi} < 70 \quad OK.$$

AZ
8mm

Harquahala Valley WPP - HARQ.FRS

5-31-80 W.E.P. 6-17-80

Pipe support, ~~footing~~ 6 8

Pg 54

$$A_s = \frac{m}{f_s j d} = \frac{(4,414.1)(12)}{(20,000)(0.860)(6.5)} = 0.47 \text{ in}^2$$

4 - #4 bars @12" = (0.2) 4 = 0.8 in² both ways

check temp. steel reqmts.

10" slab, unexposed, #4@12 OK

use both top and bottom of footing.

check bond

$V = (1.25)(3.5)(1614.3) = 7,062.6$ #

pg. 54

$$u = \frac{V}{\Sigma_o j d} = \frac{7062.6}{(1.571)(4)(.86)(6.5)} = 201.05 \text{ psi}$$

Pg. 87

allow. bond stress, non-top bars

500 psi for #4 bars > 201 OK.

Change to 12" slab —

space between steel layers for concrete

4 - ½" bars = 2" 2(3" clear) = 6"

8" + 4" concrete bet. = 12" ←

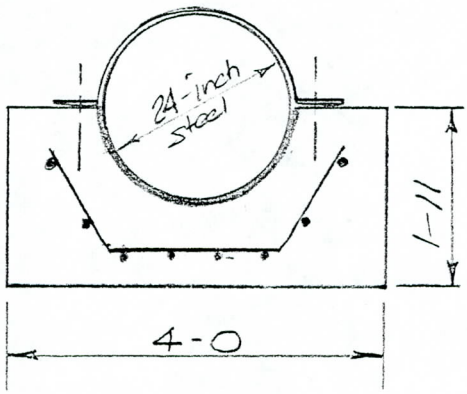
AZ
SML 6-3-80 Harquahala Valley WPP-HARQ.FRS

pipe supports, abutments 12

New Tank

steel pipe calc. pg. 5/6

Parker pg. 222




assume:

reaction at abutment 6111#, max. (simple beam)

allowable bearing of ½T/ft² or 1000#/ft² (min.)

Since cradle is 4-0 wide, use same dimension on abutment support

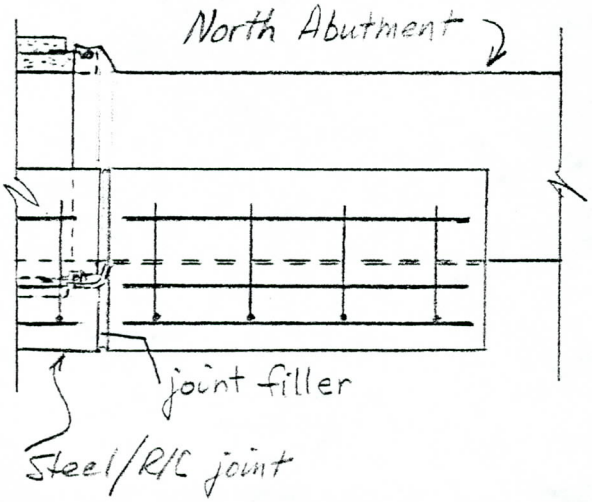
check weight of cradle /ft.

$$\left[(1.92)(4.0)(1) - \left(\frac{1}{2}\right)\frac{\pi(2)^2}{4}\right] 150^{\#}/ft^3 = 916.4\#/ft.\ L$$

assume ~ 2.0 ft long

$$[6111^{\#} + 2(916.4)] \div (2)(4)\,ft^2 = 993 < 1000^{\#}/ft^2$$

OK.




South Abutment configuration same, no pipe joint w/concrete

Steel pipe ends in Impact Basin.

AZ
Sme

Harquahala Valley WPP - HARQ. FRS

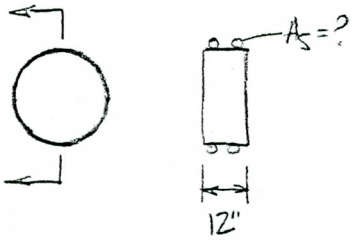
6-26-80

Collar steel (New Tank) 2 2

internal pressure at joint

El. top of dam = 1422.10
El. joint = 1389.88
32.22 ft. = 13.95 psi.

assume one foot section of pipe length




steel on each side carries ½
= 2008.8 #

$\frac{P}{S}$ $\frac{2008.8\#}{20{,}000\ \#/in^2} = 0.10\ in^2$ req'd. /ft,

less than temperature steel req'd.

11" x 12" x 0.001 = 0.13 in²/ft. (#4@12)

use #4@6

AZ Harquahala Valley WPP- HARQ.FRS

SMC 5-5-80 R.A.P. 6-5-80

Impact Basin sizing for outlets 3 3

1. Check Froude No. for New Tank Outlet.

$Q = 38.5$ cfs, $V = 12.3$ fps, $A = 3.14$ ft$^2$

use $D = \sqrt{3.14} = 1.77$ ft.

$F = \frac{12.3}{\sqrt{32.2(1.77)}} = 1.63$ $< 10$, stilling basin OK

2. vent pipe not as necessary, pipe very level

3. not necessary to make last joint level

4. Fig. 8, pg. 13, $W/D = 3.8$ $W = 3.8(1.77) = 6.73$ ft.

ES-4070 Standard Impact Basin, W=7.0
drain system not required

5. Dimensions

$H = 3W/4 = 5.06$ ft. (use 5) $c = W/2 = 3.38$ ft.
$L = 4W/3 = 9.00$ ft. $d = W/6 = 1.12$ ft.
$a = W/2 = 3.38$ ft. $e = W/12 = 0.56$ ft.
$b = 3W/8 = 2.53$ ft. $t = W/12 = 0.56$ ft. 7"?

riprap stone diam. $= W/20 = 0.34$ ft or 4.05"

Check plunge pool dimensions & riprap.

Note: top of dam Q=50 cfs, V=15.9 fps F=2.11
Dimensions same as Sheet 1 of 3
not good design, since based on freeboard storm peak. Impact Basin will perform satisfactorily for the short time this situation would be possible.

AZ
SMC

Harquahala Valley WPP

6-21-80

Outlet Channel, New Tank

Station 12+87.18, start
invert elevation = 1389.5
ground surface el. = 1392.5

set channel slope at 0.001 ft/ft and
bottom width at 14.0 ft.
assume $n = 0.03$ $z = 2$

Bureau Hydraulic & Excavation Tables 11th ed.

solve trial & error

$Q_{design} = 38.5$ cfs, $d = 1.35$ ft $V = 1.71$ fps

$Q_{freeboard} = 50$ cfs, $d = 1.58$ ft $V = 1.84$ fps

check downstream velocities, approximations

scale off topog., natural channel $\geq 20$ ft. bw.

assume $b = 20'$ $n = 0.030$ $S = 0.01$ ft/ft (topog.)
$z = 1$

$Q_{design} = 38.5$ cfs, $d = 0.6$ ft. $V = 3.0$ fps.
to New Tank Res.

el 1390 1440
1389.29 ?
el 1388 1610

$Q_{freeboard} = 50$ cfs, $d = 0.7$ ft. $V = 3.75$ fps

soil and plants are adequate to $> 3.0$ fps.

$\frac{.71}{2} \times 120 = 1440 + 60.35 = 1500.35$

water cannot flow north into CAP

$(1500 - 1287.18)(0.001) = 0.213$ ft., el. invert = 1389.29 @ 1500.35 ft.

end channel at 15+00 blend with existing terrain.

MISC. APPURTENANCES

COMPUTATION SHEET
SCS–ENG–522 REV. 3–69

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

~~3038~~ 335

GPO : 1968—O-337-998

| STATE | | PROJECT | | |
|---|---|---|---|---|
| ARIZONA | | HARQUAHALA W.P.P. – HARQUAHALA F.R.S. | | |
| BY | DATE | CHECKED BY | DATE | JOB NO. |
| J.E.B. | 13 June 80 | | 16 June 80 | |

SUBJECT
DESIGN TRASH RACK FOR NEW TANK HEADGATE

SHEET ____ OF ____

Reference TR 46

Problem :
NEED A DESIGN FOR TRASH RACK AT HEADGATE
GIVING Bar sizes & spacings

Solution :
Use TR 46 Figure C-2

Need Head in feet W.S. Elev 1419.7
Headgate Elev. 1396.0
23.7 ft.

One Cross bar

Try 1 cross bar "B" line H1 on chart

Call 2" pipe for longitude
Cross bar A = 4 X 3/8
Cross bar B = 4 I 9.5

AZ Harquahala Valley WPP- HARQ. FRS

SWL 6-27-80

slide gate works 1 1

1408.4
1392.0

TR-46, D-1

check max. water depth to ℄ gate

Principal Spillway -

1419.7

assume max. water surface at crest pr. spwy

1387.3 − 1374.0 = 13.3 ft. (18" gate)

24" handwheel, 1½-inch stem diam.,
B lift pedestal, 16 ft stem support spac.
11-6 (encased)

Drain Outlet

1420.54

assume max. water surface @ pool elev.

1399 − 1384 = 15 feet (24" gate)

30" handwheel o. 24" ball bearing, 1½" stem diam.
C lift pedestal, 16 ft. stem support spac.
10-6 (encased)

bronze lift nut

New Tank Outlet

1420.6

assume max. water surface @ 1405

1405 − 1396 = 9 ft. (24" gate)

24" handwheel, 1½" stem diam.
B lift pedestal, 16 ft. stem support
11-6 spacing - encased

C-5, Vents

Principal Spillway, no vent req'd. (riser)

Drain Outlet, 2"

New Tank Outlet, 1.25"
Use 2" if seems reasonable

AZ Harquahala Valley WPP-HARQ.FRS
SMC 4-28-80 R.A.P 4/29/80
Select no. anti-seep collars 1 2

TR-46 guide

Figure E-8

Vegetative Outlet No 1. (New Tank) will be in fine-grained soils. The conduit will pass over the top of the CAP canal.

Assume L' = 95 ft. (to chimney drain)
20% increased flow path (1.20)

requires 5 collars.

Vegetative Outlet #2 (Sta. 746+00) will be in coarse-grained soils (GM). The conduit will pass under the CAP canal.

Assume L' = L = 224' (dam)
15% increased flow path (1.2)

dam requires 8 collars

Foundation material is expected to be GP-GM or GM with layers of SM material possible. Vertical drainage is expected to predominate

place 2 collars d.s. from CAP aqueduct

10 collars total (Dam)
5 collars total (New Tank)
15

Re-checked on 6/30/80
R.A.P

AZ.
SMC

Harquahala Valley WPP - HARQ.FRS

7-24-80

Specification 41

Availability of C-300, 1, 2, 3 pipe (AWWA) has not been reliable in Arizona in the past, therefore it is considered desirable to allow some option. Since TR-60 criteria varies with different types of pipe, the Specified 3-edge bearing shall be as follows:

48-inch R/C Pressure Pipe

SF=1.33 C-300 Reb = 18,600 #/ft (.01")

SF=1.00 C-301 Reb = 14,000 #/ft. (.001")

24-inch R/C Pressure Pipe

SF=1.33 C-300 Reb = 9,700 #/ft (.01")

SF=1.00 C-301 Reb = 7,300 #/ft. (.001")

AZ
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Harquahala WPP - HARQ. FRS

8-4-80

Riprap summary 1

Possible locations for riprap are as follows:

Principal Spillway; inlet & outlet
Emergency spillway; inlet, sides and outlet
Drain Outlet; inlet & outlet
New Tank Outlet; inlet & outlet

Principal Spillway

The Principal Spillway location is on GM, GW and GP soils — not very erosion prone. The inlet is an open riser. There is a slide gate to drain the sediment pool, but it is contained. Therefore, the inlet has no high velocity flow adjacent to soils.

The outlet is a SAF basin. Downstream velocities are expected to be near 1.5 fps, which is no problem in these soils. Turbulence at the SAF sill and possible wave erosion will be protected against with an 18-inch layer of riprap. No bedding is necessary with these soils. (See riprap design, principal spillway, 6-30-80.)

AZ Harquahala Valley WPP - HARQ. FRS

SWL 8-4-80

Riprap Summary 2

Emergency Spillway

The emergency spillway entrance requires minimal protection due to relatively low velocities. The sides of the chute only need protection from potential splash and normal rainfall runoff. 18-inches of rock riprap is proposed for both locations. Since backfill and embankment soils are GM, no bedding is required.

The geologist, Paul Pedone, expects rock throughout the outlet channel bottom and sides, therefore no protection is required for the outlet.

Drain Outlet

Inlet velocities are 1.26 fps at peak flow (50 cfs) and nearly 8 fps at low flows if the pipe flows full. Since the latter condition is not expected to happen for any length of time — if ever — the existing GM material is considered adequate protection. Maintenance

AZ
SML

Harquahala Valley WPP - HARQ.FRS

8-4-80
Riprap summary



may be required in the future.

The outlet to Drain Outlet is a Submerged Pipe Outlet Basin, as described in a write-up by Greg Cunningham October of 1964. Due to the lack of experience with this type of structure, larger riprap is called for than design requires ($d_{75}$ is 7 to 11+ inches instead of the required 3 inches). The riprap shall be 3 feet thick on 12 inches of bedding in the bottom of the basin where there is some erosion potential before the basin fills. The sides and ends shall have 2 feet of riprap on 6 inches of bedding. (See drawings.)

New Tank Outlet

Inlet velocities are 0.97 fps at peak flow (38.5 fps) with a potential 4.6 fps at low flow with full pipe. These soils are SM & ML so this

AZ
SMC 8-4-80

Harquahala Valley WPP - HARQ.FRS

Riprap Summary 4

may cause a maintenance problem. The riprap called for on this project would require 2 bedding layers on this soil. The potential damage if erosion does occur is minimal. Maintenance can take care of it if it is ever required.

The outlet structure to New Tank Outlet is an impact basin. Velocities are only expected to be a problem in the immediate 2-3 feet from the sill. The soils are very erosive, though, so ample riprap will be provided by 2 feet on 1 foot of bedding downstream and 18 inches on 6 inches of bedding on the side slopes and behind the wing wall.

All designed riprap and bedding has been adjusted to one spec. each for Harquahala FRS as follows:

AZ
SML 8-4-80 Harquahala Valley WPP - HARQ.FRS

Riprap Summary 5

## Riprap

| Particle size | Percent passing |
|---|---|
| 18-inch | 100 |
| 12-inch | 65-100 |
| 6-inch | 35-60 |
| 4-inch | 25-45 |
| 3-inch | 15-40 |
| 1/2-inch. | 0-10 |
| #4 | 0-2 |

## Bedding

| Particle size | Percent passing |
|---|---|
| 4-inch | 100 |
| 3-inch | 75-100 |
| 1 1/2-inch | 50-85 |
| 3/4-inch | 35-70 |
| 1/2-inch | 25-60 |
| #4 | 10-40 |
| #10 | 0-25 |
| #40 | 0-5 |

AZ
SMC

Harquahala Valley WPP - HARQ. FRS

6-30-80

Riprap design, principal spillway 1 2

Check velocity at sill of SAF basin.

@ $Q = 390$ cfs, $D_2' = 6.4$ ft. $b = 12.0$ ft.

$A = (6.4)(12.0) = 76.8$ ft$^2$

$V = 390/76.8 = 5.08$ fps

Pg. 209, Bulletin EM, No. 25

<4" $D_{40}$

USDT
FHA
712-1
0.18 ft. dia.
= 2.2"
ISBASH
0.33 ft.
= 3.96"
USBR

@ $Q = 221.23$ cfs, $D_2' = 4.38$ ft $b = 12.0$ ft.

$A = 4.38(12) = 52.56$ ft$^2$

$V = 221.23/52.56 = 4.2$ fps

$D_{40} = 2.5$"

Check Far West States, Fig. 6-13d
method does not apply. (no riprap req'd.)

Existing soils nearly adequate (GW)
assume existing soils good bedding
and riprap as follows, 18" thick.

| Size | % passing | |
|---|---|---|
| 18-inch | 100 | adjusted to |
| 12-inch | 65-100 | conform to other |
| 6-inch | 35-60 | locations for |
| 4-inch | 25-45 | |
| 3-inch | 15-40 | |
| ½-inch | 0-10 | |
| #4 | 0-2 | riprap. SMC 7-25-80 |

SCS-ENG-353 (REV. 3-70)
FILE CODE ENG-22

# MATERIALS TESTING REPORT

U. S. DEPARTMENT of AGRICULTURE
SOIL CONSERVATION SERVICE

# SOIL CLASSIFICATION

LABORATORY NO. 3/306 335    2/2

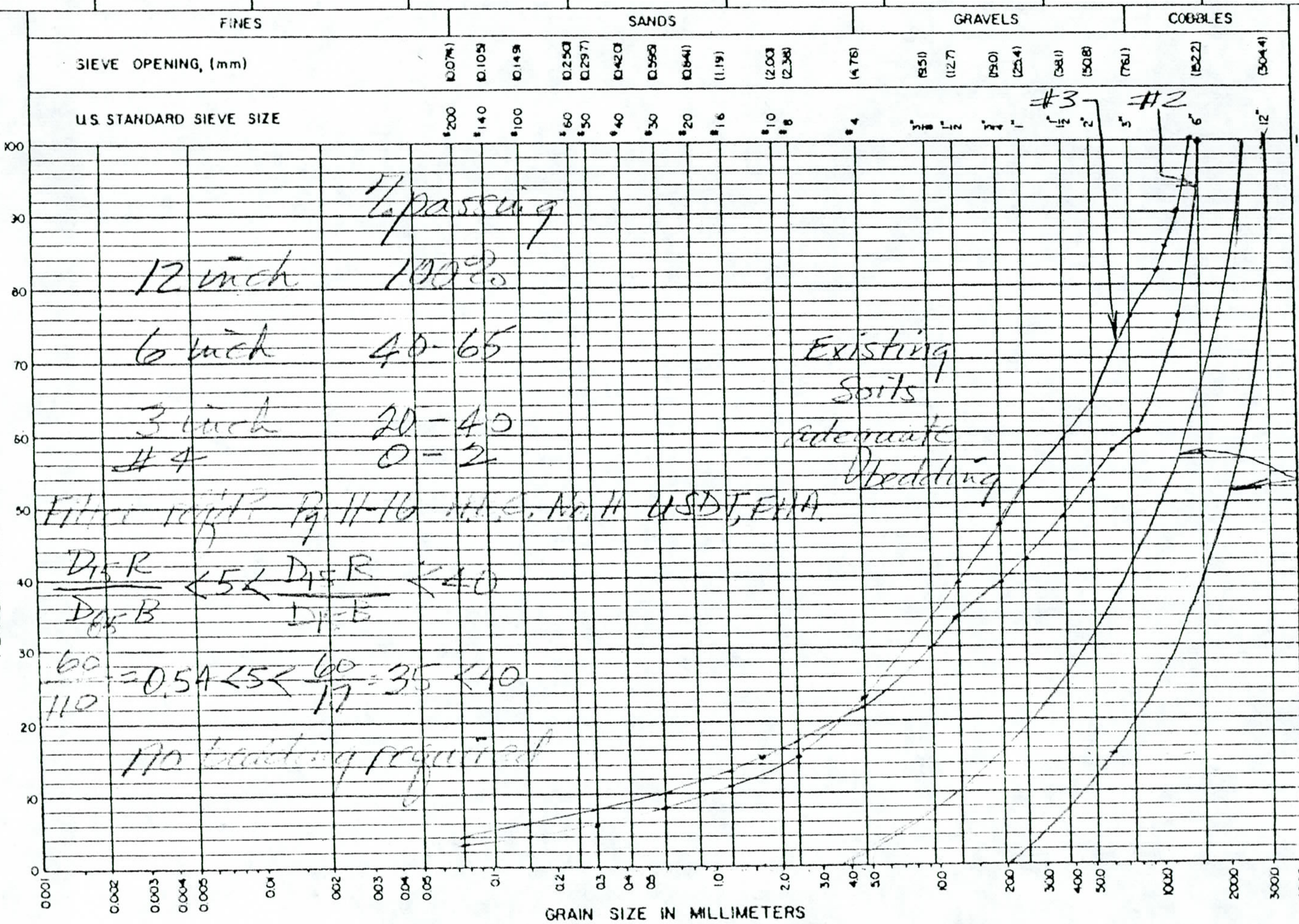
| PROJECT and STATE | FIELD SAMPLE NO. | DEPTH | GEOLOGIC ORIGIN | SAMPLE LOCATION |
|---|---|---|---|---|
| Haena Kala Valley WPP - Haeo FRS | / | / | | Principal Spillway Outlet / |

| TYPE OF SAMPLE | TESTED AT | APPROVED BY | DATE |
|---|---|---|---|
| GW (#2 #3) | | | |

| SYMBOL | DESCRIPTION |
|---|---|
| | |

## GRAIN SIZE DISTRIBUTION

| $D_{10}$ | $D_{15}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{85}$ | $D_{MAX.}$ | $C_u$ | $C_c$ |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |




| SPECIFIC GRAVITY ($G_s$) | | ATTERBERG LIMITS | | | | | | SOLUBLE SALTS | SHRINKAGE LIMIT | UNDISTURBED CONDITION | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | NATURAL MOISTURE | | AIR DRY | | OVEN DRY | | | | MOISTURE | DRY UNIT WEIGHT |
| (-) #4 | (+) #4 | LL | PI | LL | PI | LL | PI | % | % | % | g/cc pcf |

REMARKS:

AZ
SMC

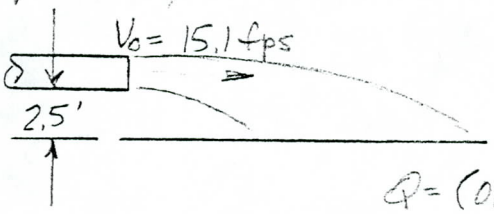
Harquahala Valley WPP - HARQ.FRS

7-1-80

Riprap @ Drain Outlet Basin 1 6

Basin is designed with $D_{75}$ of 3", since we are not sure of outlet soil conditions, riprap will be provided. The bottom will have riprap 36 inches thick, 30" rock and 6" bedding. The sides will have riprap 24" thick, 18" rock and 6" bedding, except for the North (CAP) slope which will be like the bottom (36"). Riprap will extend seven feet up the sides and down stream end and to elevation 1374 (16.5') on the upstream (CAP) end.

Check impact velocity and angle of attack if reservoir at principal spillway crest when gate is opened.




87.3 - 60 = 27.3' = H

$Q = CA\sqrt{2gH}$ $C = .936$

$Q = (0.36)(3.14)\left[(64.4)(27.3)\right]^{1/2}$

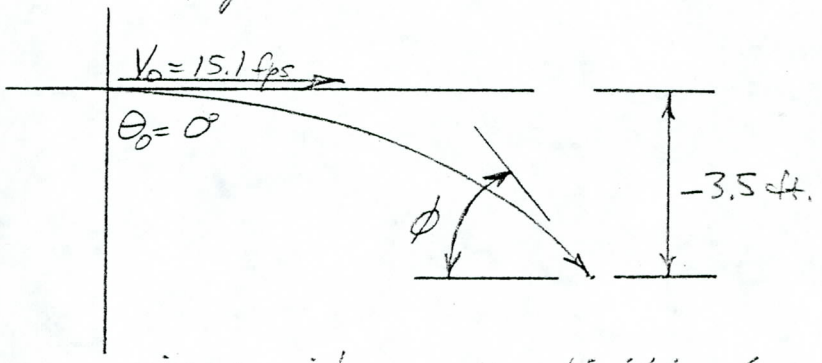
$Q = 47.4$ cfs $V = \frac{Q}{A} = \frac{47.4}{3.14} = 15.1$ fps

AZ Harquahala Valley WPP- HARQ. FRS

SMC 7-1-80

Riprap at Drain Outlet basin 2 6

Mechanics, Part II · Dynamics, JL Meriam 1952, pg. 372




air resistance negligible, $\therefore a_x = 0, a_y = -g$

$a_x = 0, \; s = v_0 t \;\; \therefore x = V_0 t \cos\theta = 15.1t$ (1)

$a_y = -g, \; s = v_0 t + \frac{1}{2} a t^2$

$\therefore \; y = 15.1t \sin\theta - \frac{1}{2} g t^2 = -\frac{1}{2} g t^2$

$y = -3.50 = -\frac{1}{2}(32.2) t^2$

$t$ @ impact $= 0.466$ seconds

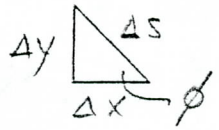
$x = (0.466)(15.1) = 7.0366$ ft.

@ $t = 0.46$ sec, $x = 6.946$ ft, $y = -3.407$ ft.

0.093
0.0906
1.0265

$\phi = \tan^{-1} \frac{\Delta y}{\Delta x} = \tan^{-1} \frac{3.5 - 3.407}{7.0366 - 6.946}$

$\phi = 45.75°$




$\bar{V} = \frac{\Delta s}{t}$

$\Delta s = \frac{\Delta y}{\sin\phi} = \frac{0.093}{0.716} = 0.1298$ ft.

$t = .466 - 0.46 = 0.006$

$\rho = \frac{\gamma}{g} = \frac{62.4}{32.2}$
$= 1.938$

$(\bar{V}_x = 15.1$ fps$)$ $\bar{V} = \frac{0.1298}{0.006} = 21.64$ fps

$F = \rho Q V = (1.933)(47.4)(21.64) = 1987.9$ #

$F_y = 1424$# $F_x = 1397$#

AZ Harquahala Valley WPP - HARQ.FRS

SMC 7-2-80

Riprap at Drain Outlet basin 3 6

Volume of basin to 7 ft. depth (full disip.)

$V = (T + B + 4M)\frac{d}{6}$

$B = 10 \times 50 = 500\ ft^2$ $d = 7$

$T = [4(7)+10][2(7)+50+(1.5)7] = 2,831\ ft^2$

$M = [4(3.5)+10][2(3.5)+50+(1.5)3.5] = 1494\ ft^2$

$V = [2831 + 500 + 4(1494)]\ 7/6 = 10,858.2\ ft^3$

(402.2 c.y.)

at 47.4 cfs $\frac{10,858.2\ cf}{47.4\ cfs} = 229.1$ sec. or 3.8 min.

(one foot deep in just over 10 seconds)

$V@3.5$ ft deep, $= \frac{47.4}{[(3.5)2+10]3.5} = 0.797$ fps

Using channel velocity techniques, riprap would not even be required. Using impact velocity, rock as follows would be required:

basin empty, bouyant weight not applicable

$G_s = 2.7$ $\gamma = 168.48\ \#/ft^3$ 1387 # req'd.

sphere $V = \frac{\pi d^3}{6}$ req'd $V = \frac{1387}{168.48} = 8.23\ ft^3$

$d_{req.} = \sqrt[3]{\frac{(6)(8.23)}{\pi}} = 2.5$ ft. (30")

(This checks with chart pg. 209, USBR Engineering Monograph No. 25. if $G_s = 2.65$)

AZ Harquahala Valley WPA HARQ. FRS
SML 7-2-80
Riprap at Drain Outlet basin 4 6

Actual impact velocity on empty basin will be negligible. If the gate is left open, water will gradually fill the basin with low flows
($\Delta H_{min.} = 1384 - 1357.5 = 26.5$ ft., $S_{ave} = 6\%$)
assume circular channel, part full
depth = 0.4 ft. diam. = 2.0 ft.
Kings. 7-30
area = 0.4472 ft$^2$ hyd. rad. = 0.242
$V = \left(\frac{1.486}{0.013}\right)(0.06)^{1/2}(.242)^{2/3} = 10.87$ fps
5 of 6% $Q = 4.86$ cfs (fills basin in 37 minutes)
Conservative $F = \rho Q V = (1.938)(4.86)(10.87) = 102.38$ #
slope of $102.38 / 168.48 = V = \frac{\pi d^3}{6}$
pipe is $d = 1.05$ ft. diameter
flat at (Monograph 25 calls for 17" diam, $\delta = 165$ #/ft$^3$, constant flow velocity rather than impact.)
the end.

If the gate is opened when the reservoir is full, the time to open the gate manually will be adequate to fill the basin at gradually increasing velocities with gradually reduced impact on riprap.
Use Dmax 18", D60 min 6", Dmin #4

AZ Harquahala Valley WPP - HARQ.FRS

SWL 7-2-80

Riprap @ Drain Outlet basin 6 6

Riprap gradation,

| | | part. size | % passing |
|---|---|---|---|
| $D_{max}$ | 18" | 18" | 100 |
| $D_{40}$ | 12-18" | 12" | 20-40 |
| $D_{25}$ | 7-12" | 6" | 5-20 |
| $D_5$ | 3-9" | 3" | 0-10 |
| | | #4 | 0-5 |

Bedding gradation,

| | | | % pass. | |
|---|---|---|---|---|
| $D_{max}$ - 3" | | 3" | 100 | bedding shall not |
| $D_{75}$ | 3/4-3" | 2" | 50-90 | be finer than |
| $D_{50}$ | 3/8-2" | 1" | 25-75 | this, coarse side |
| $D_{25}$ | #8-1" | #4 | 5-35 | might be more |
| $D_{15}$ | #20-3/4" | #200 | 0-3 | flexible if |
| $D_3$ | #200-3/8" | | non-plastic | well-graded. |

Bedding will be 6 inches thick under all riprap in basin. Riprap will be 30" deep on basin floor and upstream slope (CAP) and 18" thick (⊥) on other 3 slopes.

Note! Superceded 7-25-80 SWL
See Principal Spillway riprap.

AZ
SMM

Harquahala Valley WPP- HARQ.FES

7-24-80

Riprap New Tank Impact Basin 1 3

TR-46, Fig. F-3

$H_{max}$ = 1422.1 - 1389.5 = 32.6 ft.

(Emergency Spillway Hydrograph 10 ft less)

Diam. = 24-inch

$D_{50}$ reqd. 6.2 inches use 6 for dimens.

$3(D_{50})$ = 18 inches

6-inch bedding

Impact Basin Sill top to toe wall bottom is 4'-1"

Call for 24" of 12-inch riprap with 12" of bedding at sill.

bank protection, 18 inches on 12" bedding

Bedding thickness increased to provide additional protection to erosive soils from piping

AZ
SMC

Harquahala Valley WPP- HARQ.FRS

7-25-80

2 3

Use of Riprap for Bank Protection
Hydraulic Engrg Circular No. 11 June 67

$D_{85}$ base ~ 5.0mm $D_{15}$ base ~ .004mm est.

$D_{15}$ riprap, low curve 20mm high c. 75mm

$$\frac{D_{15L}}{D_{85}}\frac{R}{B} = \frac{20}{5} = 4 < 5 \quad \text{OK.}$$

$$\frac{D_{15H}}{D_{85}}\frac{R}{B} = \frac{75}{5} = 15 \not< 5$$

$$\frac{D_{15L}}{D_{15}}\frac{R}{B} = \frac{20}{.004} = 5{,}000 \not< 40$$

check bedding gradation

$D_{15L} = 1$ $D_{15H} = 7$

$$\frac{D_{15H}}{D_{85}}\frac{R}{B} = \frac{7}{5} < 5 \text{ OK.}$$

$$\frac{D_{15L}}{D_{15}}\frac{R}{B} = \frac{1}{.004} = 250 \text{ mm} \not< 40$$

1) No water table exists or is ever likely to exist at this location.
2) High velocities are only expected or possible for a very short distance (1-2 feet) adjacent to the sill.
3) Call for 2x thickness normally req'd. of bedding — check maintenance.

SCS-ENG-353 (REV. 3-70)
FILE CODE ENG-22

LABORATORY NO 3/3

| MATERIALS TESTING REPORT | U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE | SOIL CLASSIFICATION 32/0f 335 |
|---|---|---|

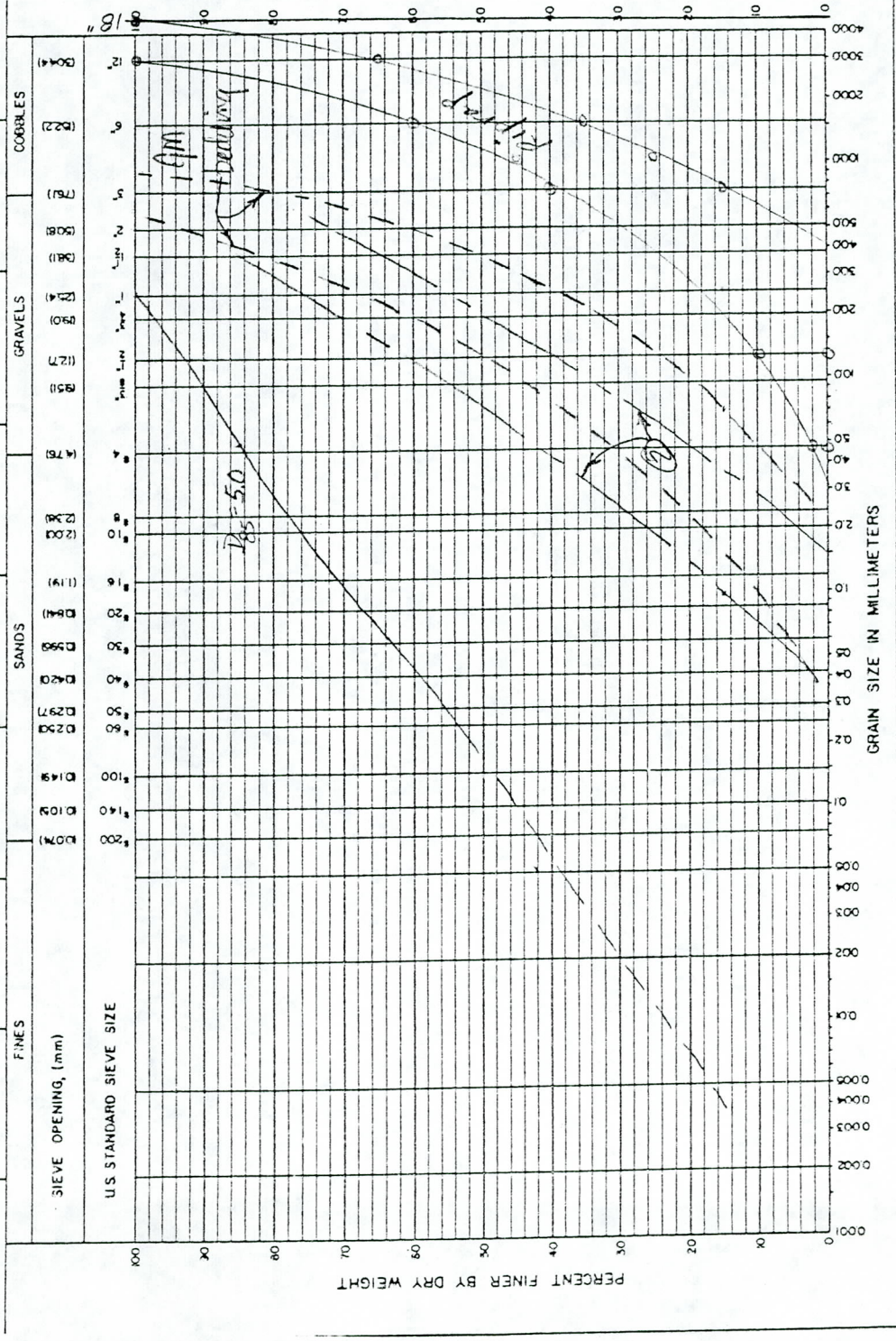
PROJECT and STATE: Harquahala Valley WPP-HARQ. FRS | SAMPLE LOCATION: New Tank Outlet

FIELD SAMPLE NO. | DEPTH | GEOLOGIC ORIGIN

TYPE OF SAMPLE: Typical | TESTED AT | APPROVED BY: [illegible] | DATE: 7-25-80

SYMBOL | DESCRIPTION: Riprap & Bedding @ New Tank to conform w/ rest of job.

GRAIN SIZE DISTRIBUTION




| $D_{90}$ | $D_{15}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{85}$ | $D_{MAX}$ | $C_u$ | $C_c$ |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

SPECIFIC GRAVITY ($G_s$): (-) #4 | (+) #4

ATTERBERG LIMITS: NATURAL MOISTURE (LL, PI) | AIR DRY (LL, PI) | OVEN DRY (LL, PI)

SOLUBLE SALTS: %

SHRINKAGE LIMIT: %

UNDISTURBED CONDITION: MOISTURE %; DRY UNIT WEIGHT g/cc, pcf

REMARKS:

United States Department of Agriculture
Soil Conservation Service

3008 Federal Building
Phoenix, Arizona 85025

Susanne
3220f
335

Subject: ENG - Geology - Supplemental Geologic Investigation of Harquahala FRS

Date: March 4, 1980

To: Ralph Arrington
State Conservation Engineer

On January 25, 1980, at the request of Susanne Leckband, I excavated a 25' deep test pit in the vicinity of the proposed stilling basin in order to determine the characteristics of soil materials in that area. All materials excavated were classified as gravels. Materials encountered are believed to be representative of materials which will be encountered in the basin area. Samples were taken at depths of 12 to 15 feet, 20 to 22 feet and 22 to 25 feet. These samples were tested at ATL Testing Laboratory. A copy of the log of test hole and copies of the Report of Laboratory Tests are attached. Ms. Leckband was provided with copies of this data earlier.

Aubrey Sanders Jr.
Geologist

USDA/SCS
AS:vl

SCS-F 333
REV.

EPARTMEI GRICULTURE
SOIL CONS TION SERVICE

## LOG OF TEST HOLES

| | | |
|---|---|---|
| WATERSHED: Harquahala | SUB-WATERSHED: | SITE NO.: Harquahala FRS |
| LOCATION: Maricopa County, Arizona | OWNER: | STATE: Arizona |
| LOGGED BY: A. C. Sanders Jr. | DATE: 1/29/80 | PROJECT: WP-07 ____ WP-08 ____ FP-03 ____ P.L.-46 ____ |
| DRILLING EQUIPMENT: Backhoe | LOCATION OF HOLES: Principal Spillway | |

| HOLE NO. | STA. & SURFACE ELEVATION | HOLE DEPTH FROM FT. | HOLE DEPTH TO FT. | DESCRIPTION OF MATERIALS | N | USCS | TYPE BIT USED | SAMPLES NO. | SAMPLES TYPE[1] | SAMPLES FROM FT. | SAMPLES TO FT. | SAMPLES CSE. % | SAMPLES REM.[2] MIN. DIAM. | SAMPLES REC.[3] % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 13 + 63 | 0.0 | 3.0 | Gravel; sandy, silty, moist, reddish-brown. | GM-GP | | | | | | | | | |
| | El. 1366.4 | | | w/about 20% cobbles to 12" diameter. | | | | | | | | | | |
| | | | | Loose. Median diameter G est. 1". | | | | | | | | | | |
| | | 3.0 | 12.0 | Gravel; very sandy, w/about 20% cobbles | GP | | | | | | | | | |
| | | | | to 12" diameter and occ. boulder up to 18" diameter. | | | | | | | | | | |
| | | | | Dense. Slight to moderate cemented W/$CaCO_3$. Median | | | | | | | | | | |
| | | | | diameter. G. estimated 1". Gravel is angular to | | | | | | | | | | |
| | | | | subrounded. | | | | | | | | | | |
| | | 12.0 | 19.0 | Gravel; sandy, w/about 25% Cobbles to 12" diameter and | GP-GW | | | 1 | D | 12.0 | 15.0 | | | |
| | | | | about 5 to 10% boulders to 18" diameter. Dense, | | | | | | | | | | |
| | | | | moderate to weakly cemented. Median G. estimated 1.5" | | | | | | | | | | |
| | | 19.0 | 25.0 | Gravel; sandy, w/about 25% cobbles to 12" diameter, | GP-GW | | | 2 | D | 20.0 | 22.0 | | | |
| | | | | and about 10 - 15% boulders to 24" diameter. | | | | 3 | D | 22.0 | 25.0 | | | |
| | | | | Dense, moist, w/some weak to moderate cementation. | | | | | | | | | | |
| | | | | Median G. estimated to be 1". Gravel is subangular to | | | | | | | | | | |

1. DISTURBED-UNDISTURBED-ROCK CORE 2. COARSE MATERIAL REMOVED 3. PERCENT SAMPLE RECOVERY

SHEET ____ OF ____ SHEETS

323 of 335

(continuation)

SCS-F 333
REV.



DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

LOG OF TEST HOLES

| | | |
|---|---|---|
| WATERSHED: Harquahala | SUB-WATERSHED: | SITE NO.: Harquahala FRS |
| LOCATION: Maricopa County, Arizona | OWNER: | STATE: Arizona |
| LOGGED BY: A. C. Sanders Jr. | DATE: 1/29/80 | PROJECT: WP-07 ____ WP-08 ____ FP-03 ____ P.L.-46 ____ |
| DRILLING EQUIPMENT: Backhoe | | LOCATION OF HOLES: Principal Spillway |

| HOLE NO. | STA. & SURFACE ELEVATION | HOLE DEPTH FROM FT. | HOLE DEPTH TO FT. | DESCRIPTION OF MATERIALS | N | USCS | TYPE BIT USED | SAMPLES NO. | SAMPLES TYPE [1] | SAMPLES FROM FT. | SAMPLES TO FT. | SAMPLES CSE. % | SAMPLES REM. [2] MIN. DIAM. | SAMPLES REC. [3] % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | subrounded. NOTE: Removed one boulder which measured | | | | | | | | | | |
| | | | | about 12" X 12" X 8" from sample #2. Sample should | | | | | | | | | | |
| | | | | be corrected for removal. | | | | | | | | | | |

1. DISTURBED-UNDISTURBED-ROCK CORE
2. COARSE MATERIAL REMOVED
3. PERCENT SAMPLE RECOVERY

SHEET ____ OF ____ SHEETS

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ATL Testing Laboratories
A Division of R & D Engineering Associates, Inc
Engineers • Geologists

Boyd Smith, PE

Donald L. Green, PE

# REPORT OF LABORATORY TESTS

For: Soil Conservation Service
111 West Monroe, Suite 326
Phoenix, Arizona

Project: Harquahala FRS Principal Spillway

Source of Sample: #1 12'-15'

Date: January 31, 1980

Lab No.: 2040

Material: Soil

Sampled By: A. Sanders

Date Received: 1-25-80

MECHANICAL ANALYSIS:

| Sieve Size | % Retained (Indiv.) | % Passing (Cumul.) | Specifications |
|---|---|---|---|
| 6" | 0 | 100 | |
| 5 | 13 | 87 | |
| 3½ | | | |
| 3 | 6 | 81 | |
| 2½ | 15 | 66 | |
| 2 | 4 | 62 | |
| 1½ | 4 | 58 | |
| 1 | 6 | 52 | |
| 3/4 | 5 | 47 | |
| 1/2 | 7 | 40 | |
| 3/8 | 4 | 36 | |
| 1/4 | 6 | 30 | |
| #4 | 4 | 26 | |
| 8 | 6 | 20 | |
| 10 | 1 | 19 | |
| 16 | 4 | 15 | |
| 30 | 4 | 11 | |
| 40 | 1 | 10 | |
| 50 | 1 | 9 | |
| 100 | 2 | 7 | |
| 200 | 2 | 5 | |

Liquid Limit Non-Plastic
Plastic Limit
Plasticity Index
Soil Classification
Specific Gravity
Moisture 5.8 %
Absorption %
Weight/Cu.Ft. Rodded lbs.
Loose lbs.
Fineness Modulus
Organic Impurities
Abrasion (L.A.) % wear 500 rev., Loss %
Soundness (Sodium, Magnesium Sulphate)
cycles

Asphalt Content:
(% of Total Sample) =
(% of Dry Aggregate =
Moisture-Density Relationship:

Maximum Dry Density pcf
Optimum Moisture %

Respectfully submitted,
ATL TESTING LABORATORIES

Daniel P. Matthews

Daniel P. Matthews

ATL Testing Laboratories
A Division of R & D Engineering Associates, Inc
Engineers • Geologists

Boyd Smith, P.E

Donald L. Green, P.E

# REPORT OF LABORATORY TESTS

For: Soil Conservation Service
111 West Monroe, Suite 326
Phoenix, Arizona

Project: Harquahala FRS Principal Spillway

Source of Sample: #2 20'-22'

Date: January 31, 1980

Lab No.: 2042

Material: Soil

Sampled By: A. Sanders

Date Received: 1-25-80

MECHANICAL ANALYSIS:

| Sieve Size | % Retained (Indiv.) | % Passing (Cumul.) | Specifications |
|---|---|---|---|
| 6" | 0 | 100 | |
| 5½ | 11 | 89 | |
| 5 | 13 | 76 | |
| 3½ | 16 | 60 | |
| 2½ | 3 | 57 | |
| 2 | 4 | 53 | |
| 1½ | 5 | 48 | |
| 1 | 6 | 42 | |
| 3/4 | 3 | 39 | |
| 1/2 | 5 | 34 | |
| 3/8 | 4 | 30 | |
| 1/4 | 5 | 25 | |
| #4 | 3 | 22 | |
| 8 | 5 | 17 | |
| 10 | 1 | 16 | |
| 16 | 3 | 13 | |
| 30 | 3 | 10 | |
| 40 | 1 | 9 | |
| 50 | 1 | 8 | |
| 100 | 2 | 6 | |
| 200 | 2 | 4 | |

Liquid Limit Non-Plastic
Plastic Limit
Plasticity Index
Soil Classification
Specific Gravity
Moisture 8.8 %
Absorption %
Weight/Cu.Ft. Rodded lbs.
Loose lbs.
Fineness Modulus
Organic Impurities
Abrasion (L.A.) % wear 500 rev., Loss %
Soundness (Sodium, Magnesium Sulphate)
cycles

Asphalt Content:
(% of Total Sample) =
(% of Dry Aggregate =
Moisture-Density Relationship:

Maximum Dry Density pcf
Optimum Moisture %

Respectfully submitted,
ATL TESTING LABORATORIES

Daniel P. Matthews
Daniel P. Matthews

# ATL Testing Laboratories

*A Division of R & D Engineering Associates, Inc*

Engineers • Geologists

Boyd Smith, P.E. Donald L. Green, P.E.


## REPORT OF LABORATORY TESTS

For: Soil Conservation Service
111 West Monroe, Suite 326
Phoenix, Arizona

Project: Harquahala FRS Principal Spillway

Source of Sample: #3 22'-25'

Date: January 31, 1980

Lab No.: 2043

Material: Soil

Sampled By: A. Sanders

Date Received: 1-25-80

MECHANICAL ANALYSIS:

| Sieve Size | % Retained (Indiv.) | % Passing (Cumul.) | Specifications |
|---|---|---|---|
| 5½ | 0 | 100 | |
| 5 | 12 | 88 | |
| 4 | 6 | 82 | |
| 3 | 6 | 76 | |
| 2½ | 6 | 70 | |
| 2 | 6 | 64 | |
| 1½ | 5 | 59 | |
| 1 | 7 | 52 | |
| 3/4 | 5 | 47 | |
| 1/2 | 8 | 39 | |
| 3/8 | 5 | 34 | |
| 1/4 | 7 | 27 | |
| #4 | 4 | 23 | |
| 8 | 8 | 15 | |
| 10 | 1 | 14 | |
| 16 | 3 | 11 | |
| 30 | 3 | 8 | |
| 40 | 1 | 7 | |
| 50 | 1 | 6 | |
| 100 | 2 | 4 | |
| 200 | 1 | 3 | |

Liquid Limit Non-Plastic
Plastic Limit
Plasticity Index
Soil Classification
Specific Gravity
Moisture 4.4 %
Absorption %
Weight/Cu.Ft. Rodded lbs.
Loose lbs.
Fineness Modulus
Organic Impurities
Abrasion (L.A.) % wear 500 rev., Loss %
Soundness (Sodium, Magnesium Sulphate)
cycles

Asphalt Content:
(% of Total Sample) =
(% of Dry Aggregate =
Moisture-Density Relationship:

Maximum Dry Density pcf
Optimum Moisture %

Respectfully submitted,

ATL TESTING LABORATORIES

Daniel P. Matthews

Daniel P. Matthews

O & M GUIDE

# OPERATION AND MAINTENANCE GUIDE
for
HARQUAHALA FRS

## GENERAL

A regular program of inspection and maintenance will be required to assure that the dam is at all times ready to control storm runoff. The following items are to be used as a guide to properly operate and maintain the dam.

## OPERATION-

The three gated outlets are designed to be operated independently of each other. The design permits either open or closed pre-storm conditions, but anticipates best performance as follows:

Principal Spillway --

Leave gate closed until after storm to allow sediment to settle. Open fully until pool is drained and reclose.

Drain Outlet --

Leave gate closed unless drainage is desired or needed for safety, to permit storage of water for livestock and wildlife. If water storage is not desired, operate gate as recommended for principal spillway gate.

New Tank Outlet --

Leave gate open to permit as much water as possible to reach New Tank. If the reservoir at New Tank is full, the gate can be closed. Re-open after storms have ended.

## MAINTENANCE

Slide Gates --

Open and close each gate at least annually to be sure gates are functioning properly. Clear gate assembly and trash rack of any obstructions and make any needed repairs. Check for any soil erosion near the gates.

Principal Spillway Inlet --

Check inlet after every major storm for obstructions. Remove and dispose of any debris on trash rack or in riser.

Outlets --

Check the SAF outlet, transition and conduit for obstructions or irregularities. Particularly, look for unusual wear or flow lines within the transition that might indicate problems with high-velocity flow. Debris should be removed and disposed of. Any need for repairs should be reported to the Soil Conservation Service for evaluation of cause and repaired as necessary.

Check the Drain Outlet basin for debris, sediment and rock movement. Minor rock movement (one or two feet deep) is expected immediately downstream from the pipe and does not require repair. Sediment and debris should be removed whenever they approach the pipe invert elevation. Any major movement of rock should be reported to the Soil Conservation Service for evaluation of cause. Riprap at this site is not expected to need replacement, but the slopes may need to be re-established periodically.

Check the impact basin for sediment and debris. Remove sediment and debris as often as experience shows is necessary to permit unobstructed flow of water to New Tank.

Check all drain outlets to be sure they are unobstructed. Clean animal guards if necessary.

Rock Riprap --

Rock riprap other than in the Drain Outlet basin occurs at the SAF, the emergency spillway inlet and sides, and the impact basin. This rock riprap should be checked annually and after every major flow to appraise condition. Replace rock where needed.

Channels --

The Principal Spillway inlet channel and outlet channel; Drain Outlet outlet channel; and New Tank Outlet diversion, inlet channel and outlet channel should be checked periodically and cleared of sediment and debris area between the Drain Outlet and the Principal Spillway should be checked and cleared of any major buildup of sediment or debris after every major storm.

Embankment --

Inspection of the embankment should be performed at least annually and after major storms or earth movements. Check for transverse and longitudinal cracks in the surface of the fill, excessive erosion due to livestock travel or borrowing animals, and gullies and rills on the slopes. Make necessary repairs. Check the downstream toe for any irregularities.

Borrow Area Blanket --

Inspect the borrow area blanket for any surface irregularities after major storms. Notify the Soil Conservation Service and repair blanket, if necessary.

Emergency Spillway --

Check the structure annually and after any flow occurs in the emergency spillway. Look for excessive wear, especially at expansion joints and baffle blocks, and general condition. Clear any sediment or debris from the structure.

Fences --

Check condition of protective fences at principal spillway outlet and emergency spillway inlet periodically and make any necessary repairs. Check and repair boundary fences and gates as needed.

## O&M Costs and Financial Resources

Financial resources for O&M costs shall come from the Flood Control District of Maricopa County.

## O&M Responsibility and Procedures

The responsibility for maintenance belongs to the Flood Control District of Maricopa County. Technical assistance and advice may be obtained from the Soil Conservation Service.

## Critical Items

All items listed under "Maintenance" are considered important and critical items to the operation of the system. All of these items will be considered in special and recurring on-site inspections.

## Environmental Concerns

At present, construction of the dam is not considered a threat to the environment. However, should an adverse environmental effect occur, every reasonable effort should be made to correct the problem.

## O&M Inspection and Followup

The sponsors will inspect the dam at least annually and after each significant flow or after the occurrence of any unusual condition that might adversely affect the dam. Any supplemental inspections then determined necessary will be scheduled and agreed to at that time. A written report will be made of each inspection, describing the conditions found and the corrective action needed. A copy of each report will be provided to the Soil Conservation Service within ten (10) days of the date on which the inspection was made. All deficiencies found in the inspection shall be corrected within an agreed-to time frame between the sponsors and the Soil Conservation Service.

## State O&M Handbook

The book entitled "State of Arizona Watersheds Operation and Maintenance Handbook for Projects Installed with Assistance from the Soil Conservation Service", U.S. Department of Agriculture, Soil Conservation Service, dated May 1971, shall be made a reference to this O&M Guide.

## Time of Responsibility

The sponsors' responsibility for operation and maintenance begins when a part or all of the work of installing the floodway is completed and accepted or is determined complete by the Soil Conservation Service. This responsibility shall continue until the expiration of the evaluated life of all the installed project measures. This does not relieve the sponsors' liability which continues throughout the life of the measure or until the measure is modified to remove potential loss of life or property.

## Provisions for the Sponsors' Publication

Not applicable.

## Records

The sponsors will maintain a record of all inspections and significant actions taken by the sponsors with respect to operation and maintenance. The Soil Conservation Service may inspect these records at any reasonable time.

COST ESTIMATE

BID SCHEDULE NO. 1 HARQUAHALA FRS

| ITEM NO. | WORK OR MATERIAL | SPEC. NO. | QUANTITY | UNIT | UNIT PRICE | AMOUNT |
|---|---|---|---|---|---|---|
| 1. | Clearing and Grubbing | 2 | 700 | Acres | $400.00 | $280,000.00 |
| 2. | Seeding | 6 | 670 | Acres | $200.00 | $134,000.00 |
| 3. | Mobilization | 8 | 1 | Job | $XXXXX | $300,000.00 |
| 4. | Stripping, Common | 21 | 300,000 | C.Y. | $0.80 | $240,000.00 |
| 5. | Cutoff Trench Excavation, Common | 21 | 124,000 | C.Y. | $1.00 | $124,000.00 |
| 6. | Channel Excavation, Common | 21 | 25,200 ~~428,000~~ | C.Y. | $1.50 | $37,800.00 |
| 7. | Channel Excavation, Unclassified | 21 | 7,500 | C.Y. | $5.50 | $41,250.00 |
| 8. | Structure Excavation, Common | 21 | 19,000 ~~14,000~~ | C.Y. | $8.00 | $152,000.00 |
| 9. | Structure Excavation, Unclassified | 21 | 3,900 | C.Y. | $10.00 | $39,000.00 |
| 10. | Trench Excavation, Common | 21 | 1560 ~~1,100~~ | C.Y. | $0.80 | $1,248.00 |
| 11. | Structure Backfill | 23 | 12,000 | C.Y. | $18.00 | $216,000.00 |
| 12. | Pipe Backfill | 23 | 1150 ~~750~~ | C.Y. | $18.00 | $20,700.00 |
| 13. | Earth Fill | 23 | 4,428,000 | C.Y. | $0.90 | $3,985,200.00 |
| 14. | Reservoir Borrow Area Blanket | 23 | 470,000 | C.Y. | $1.10 | $517,000.00 |
| 15 | Embankment Drain Fill | 24 | 99,000 | C.Y. | $18.00 | $1,782,000.00 |
| 16. | Drain Fill | 24 | 565 | C.Y. | $18.00 | $10,170.00 |
| 17. | Reinforced Concrete Class 4000X | 31 | 1,326 | C.Y. | $300.00 | $397,800.00 |
| 18. | Cement | 31 | 2,000 | Bbls. | $25.00 | $50,000.00 |
| 19. | Steel Reinforcement | 34 | 149,000 | Lbs. | $0.65 | $96,850.00 |
| 20. | 48-Inch Diameter Reinforced Concrete Pressure Pipe | 41 | 464 | Lin.Ft. | $230.00 | $106,720.00 |

S.T. _____

BID SCHEDULE NO. 1 HARQUAHALA FRS (page 2)

| ITEM NO. | WORK OR MATERIAL | SPEC. NO. | QUANTITY | UNIT | UNIT PRICE | AMOUNT |
|---|---|---|---|---|---|---|
| 21. | 24-Inch Diameter Reinforced Concrete Pressure Pipe | 41 | 651 | Lin.Ft. | $ 100.00 | $ 65,100.00 |
| 22. | 16-Inch Diameter Asbestos Cement Pipe | 44 | 300 | Lin.Ft. | $ 12.50 | $ 3,750.00 |
| 23. | 12-Inch Diameter Asbestos Cement Pipe | 44 | 276 | Lin.Ft. | $ 8.50 | $ 2,346.00 |
| 24. | 10-Inch Diameter Asbestos Cement Pipe | 44 | 560 ~~60~~ | Lin.Ft. | $ 6.80 | $ 3,808.00 |
| 25. | 8-Inch Diameter Perforated Asbestos Cement Pipe | 44 | 860 ~~360~~ | Lin.Ft. | $ 5.50 | $ 4,730.00 |
| 26. | 6-Inch Diameter Perforated Asbestos Cement Pipe | 44 | 528 | Lin.Ft. | $ 9.10 | $ 4,804.80 |
| 27. | 24-Inch Diameter Steel Pipe | 52 | 132 | Lin.Ft. | $ 120.00 | $ 15,840.00 |
| 28. | Rock Riprap | 61 | 1210 ~~705~~ | C.Y. | $ 28.00 | $ 33,880.00 |
| 29. | Rock Surface Preparation | 63 | 6,000 | S.Y. | $ 1.50 | $ 9,000.00 |
| 30. | Dental Concrete | 63 | 6,000 | S.Y. | $ 10.00 | $ 60,000.00 |
| 31. | 18-Inch Diameter Slide Gate | 71 | 1 | Ea. | $ 6,600. | $ 6,600.00 |
| 32. | 24-Inch Diameter Slide Gate | 71 | 2 | Ea. | $ 7,000. | $ 14,000.00 |
| 33. | Metalwork | 81 | 1 | Job | $ ~~5,000~~ | $ 5,000.00 |
| 34. | 6-Foot Chain Link Fence | 91 | 239 | Lin.Ft. | $ 12.60 | $ 3,011.40 |
| 35. | 4-Strand Barbed Wire Fence | 92 | 78,000 | Lin.Ft. | $ 1.05 | $ 81,900.00 |
| 36. | Identification Sign | 93 | 1 | Job | $ ~~XXXX~~ | $ 1,850.00 |

S.T. _____

TOTAL $8,847,358.20