Appendix K.2

Hydrology Study

Merrell-Johnson Engineering, Inc.
CIVIL ENGINEERING ♦ SURVEYING

HYDROLOGY STUDY

For

MOJAVE SOLAR PROJECT
HARPER DRY LAKE, CA

Prepared For:

MOJAVE SOLAR LLC
Victorville, CA
July, 2009

Prepared by:

Merrell-Johnson Engineering, Inc.

12138 Industrial Blvd., Suite 240
Victorville, CA 92395
(760) 241-6146

Job No. 3001

Brad S. Merrell
Principal Engineer
R.C.E. 49423 Exp. 09/30/10

Mark D. Rowan
Project Manager

TABLE OF CONTENTS

DISCUSSION ***SECTION 1***

Introduction
Project Location
Methodology
Description
General
Existing Condition
Developed Condition
Conclusions & Recommendations

EXHIBITS ***SECTION 2***

Vicinity Map
U.S.G.S. Map
Proposed Development Plan
Drainage Plan

HYDROLOGY CALCULATIONS ***SECTION 3***

Topography Map
Off-site Hydrology Calculations
Off-Site Hydrology Map
Unit Hydrograph and Rational Calculations: 100-Year Storm
Exhibits
Soil Map
Isohyetal Map
Unit Hydrograph Data Sheets

STORM DRAIN CAPACITY CALCULATIONS ***SECTION 4***

Channel Calculations
Roadway Crossing Calculations
All Weather Crossings
Channel Bottom Crossings
Exhibits
San Bernardino County Flood Control District – Earth Channel Section

SECTION 1

DISCUSSION

INTRODUCTION

The purpose of this study was to determine the impact of the 100-year storm runoff flow from the watershed tributary to the proposed Mojave Solar Project site as delineated on the maps contained in this study. This study also examines measures to intercept the runoff flows and convey them around the project site to their historical flow locations along the northern and eastern boundaries of the property adjacent to Harper Dry Lake.

PROJECT LOCATION

The Mojave Solar Project site is located along the westerly boundary of Harper Dry Lake near the unincorporated area of Lockhart in northwesterly San Bernardino County. The project site location is highlighted on the attached vicinity map. This location was originally planned to be part of a larger solar electric generating system (SEGS) facility consisting of five separate generating facilities. Two of the five facilities were completed in the late 1980's. The Mojave Solar Project site is located on the location originally planned for two of the remaining facilities.

METHODOLOGY

The method in determining these peak runoff flows was the rational method for watershed areas under 640 acres and the unit hydrograph method for watershed areas over 640 acres as specified in the 1986 San Bernardino County Hydrology Manual. The existing offsite flow was examined and delineated from U.S.G.S. Maps: Lockhart, Kramer Junction, Kramer Hills, Twelve Gage Lake, Astley Rancho, and Wild Crossing. The computer program used for the rational method analysis routes runoff flows through the off-site sub-areas by modeling geometric channels. These channels are used for modeling the naturally occurring flowlines only and the improved channels do not exist within the off-site watershed areas.

A drainage plan was developed for the project site, modeled after the drainage plan originally prepared for the existing SEGS project. The storm runoff flow from the tributary area for Streams 8 & 9 was analyzed and compared to the identical tributary

area from the original SEGS study. The flows from the original study were slightly higher and the more conservative numbers were used to model the corresponding channels for the current project. Hoffman Road, which runs along the southern boundary of the existing SEGS facilities, is elevated several feet above the adjacent terrain forming an embankment which intercepts drainage flows tributary to the existing SEGS facilities and directs them eastward toward Harper Dry Lake. Storm runoff from portions of the drainage areas west of the Mojave Solar Project site will follow their historical flow paths and be intercepted by this existing embankment and be conveyed to Harper Dry Lake.

The off-site sheet flows tributary to the Mojave Solar Project will be intercepted along the southern and eastern boundaries of the site, conveyed around the project site within improved drainage channels, and outlet within their historical flow locations along the northern and easterly project boundaries. Measures will be employed to return the channelized flows to their historical sheet flow conditions as they leave the project site and flow into Harper Dry Lake.

The parameters of the off-site tributary sub-areas examined in this study are shown in Table A and are outlined on the attached U.S.G.S. map.

Table A

Sub-area	**Elevation Difference (ft.)**	**Length (ft)**	**Area (Acres)**	**Avg. Slope (ft/ft)**
Stream 3	65.0	7,356	210.5	0.0088
Stream 4	218.0	35,535	3520.0	0.0061
Stream 5	66.0	4,780	229.4	0.0138
Stream 6	834.0	72,811	12,134	0.0115
Stream 7	40.0	4,039	54.1	0.0099
Streams 8 & 9	802.0	74,334	42,142	0.0108
Stream 10	117.0	10,557	530	0.0111

DESCRIPTION

GENERAL:

The project site and tributary watershed area is comprised of generally vacant, undeveloped land with some scattered residences. Some land parcels within the tributary watershed area and most of the land parcels within the project boundaries were previously utilized for agricultural purposes and consist of disturbed land.

EXISTING CONDITION:

The project site is located along the south and west shores of Harper Dry Lake in an unincorporated area of San Bernardino County. The tributary watershed areas are generally sloping at less than 1.0 % from southwest to northeast towards the dry lake bed. Storm runoff flows begin as sheet flow within the upper reaches of the watershed and confluence as they approach the project site and the dry lake. The existing vegetation on the site consists of desert brush and vegetation in sandy surface soils.

There is evidence of minor runoff in the form of sheet flows across the project site. There is also some minor evidence of scour, within the tributary watershed area, from larger storm events that generally follow the existing swales as indicated on the enclosed U.S.G.S. maps. These existing swales disappear upstream of the project site due to previous agricultural activity and grading disturbances in the area. The 100-year flood plain has not been established for the Harper Dry Lake.

The results of this study are summarized in Table B. Calculations sheets are in Section 3 of this report.

Table B

Off-Site Sub-Area	**Q_{100} (cfs)**
Stream 3	181
Stream 4	2,162
Stream 5	290
Stream 6	3,992
Stream 7	57
Streams 8 & 9	14,788
Stream 10	458

DEVELOPED CONDITION:

The proposed development for this site is a solar energy power generation plant. This plant site will include a power generation area, fields of solar panels, and various plant support areas. The proposed development plan for the Mojave Solar Project is attached to this report.

CONCLUSIONS AND RECOMMENDATIONS

During our field investigation of the site we observed the existing conditions as stated previously. The calculated 100-year storm runoff flows enter the site as sheet flows along seven (7) boundary sections as indicated on the attached drainage maps. The 100-year runoff flows crossing the project boundary sections are tabulated in Table B above.

A drainage plan has been developed for the project site. Drainage channels will be constructed to intercept the storm runoff as sheet flow along the southern and western boundaries of the project and to convey these storm flows around the project site. Storm runoff flows tributary to the western boundary of the project will be conveyed to the existing embankment of Hoffman Road where they will follow their historical flow path to Harper Dry Lake. Storm runoff flows tributary to the southern project boundary will be conveyed to a spreading ground constructed along the northern project boundary. This spreading ground will be designed to dissipate the energy of the runoff flow and return the flow to its historical sheet flow parameters as it leaves the project site and flows into the dry lake bed. The spreading ground will be designed to minimize disturbance of the dry lake bed and surrounding areas.

The channels will be designed and constructed following the flow design requirements of the San Bernardino County Flood Control District to include flow bulking, erosion protection, and free-board. Preliminary channel design requirements and channel data are summarized in Table C. of this report. The ultimate design of the storm channels and spreading ground is contingent upon the final site and grading plans for the project and will be designed in conjunction with the approved, engineer's plans for the site.

Preliminary calculations were performed for two all-weather channel crossings to the project. An all-weather crossing will be constructed on Harper Lake Road crossing drainage Channel A. A second all-weather crossing will be constructed on Lockhart Road crossing Channel D. These crossings will provide all-weather paved access to both power islands and access to adjacent property owners. These crossings will provide 24-hour, all-weather emergency access to the project and to adjacent properties. The final design of the crossings will be analyzed in conjunction with the approved engineer's plans for the project.

Table C

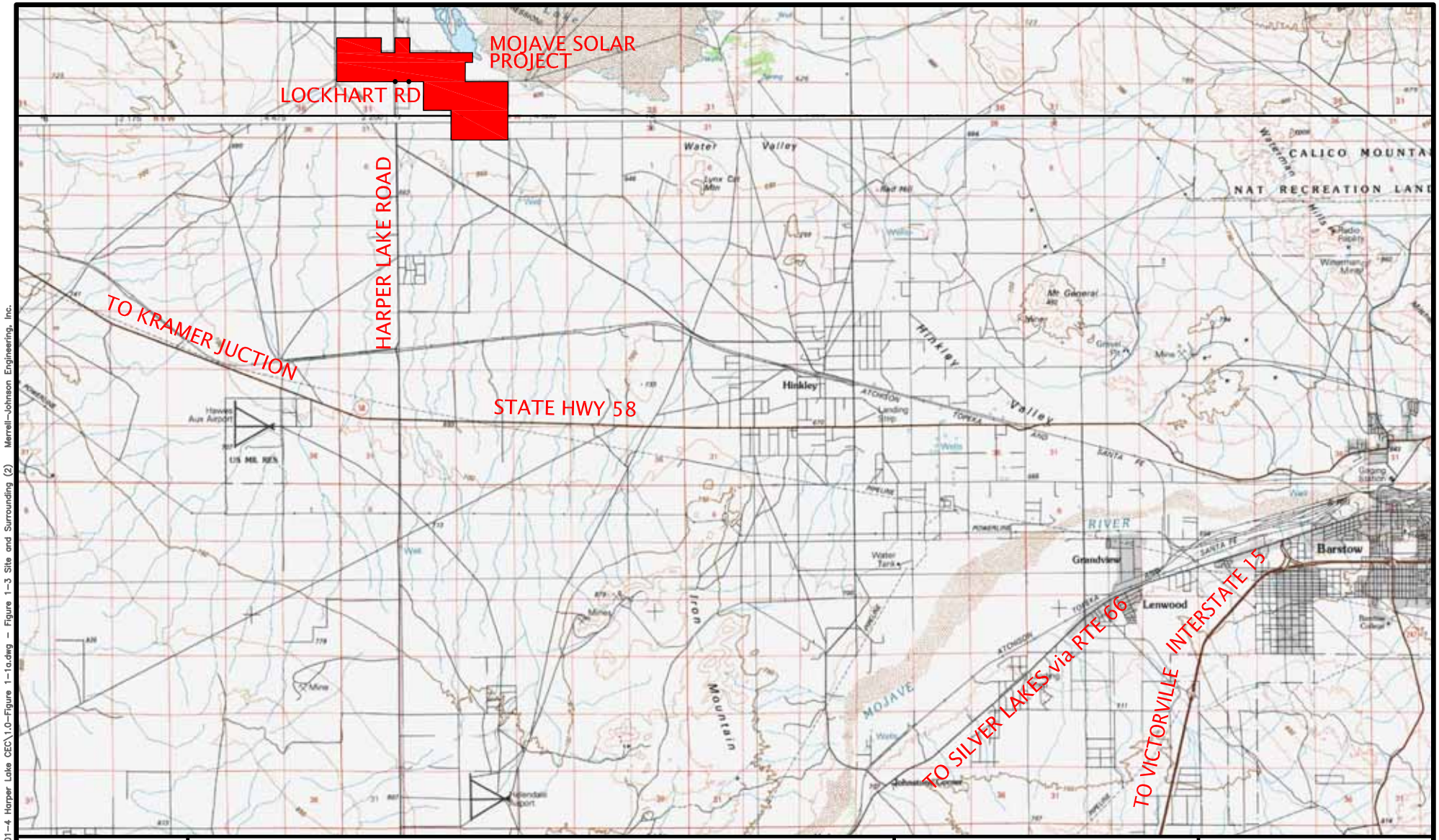
Preliminary Channel Data for Master Plan of Drainage

Channel	**Bottom Width**	**Flow Depth**	**Length (ft)**	**Flow (cfs)**	**Avg. Slope (ft/ft)**
A-1	180	6.0	11,400	14,788	0.0070
A-2	240	6.0	5,280	14,788	0.0040
A-3	260	6.0	2,300	210.5	0.0070
B	90	5.0	2,700	4,282	0.0057
C	55	5.0	4,770	2,162	0.0050
D	90	5.0	2,774	6,444	0.0097
E	65	4.0	13,520	1,477	0.0019
F	20	3.0	5,280	458	0.0070

SECTION 2

EXHIBITS

VICINITY MAP



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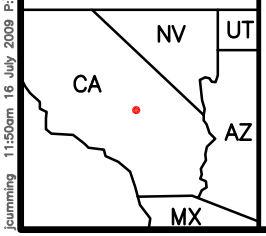


Legend

Plant Site Boundary

0 1000' 2000' 3000'

1:24,000

MOJAVE SOLAR PROJECT

Figure 1-2
Vicinity Map

MOJAVE SOLAR LLC

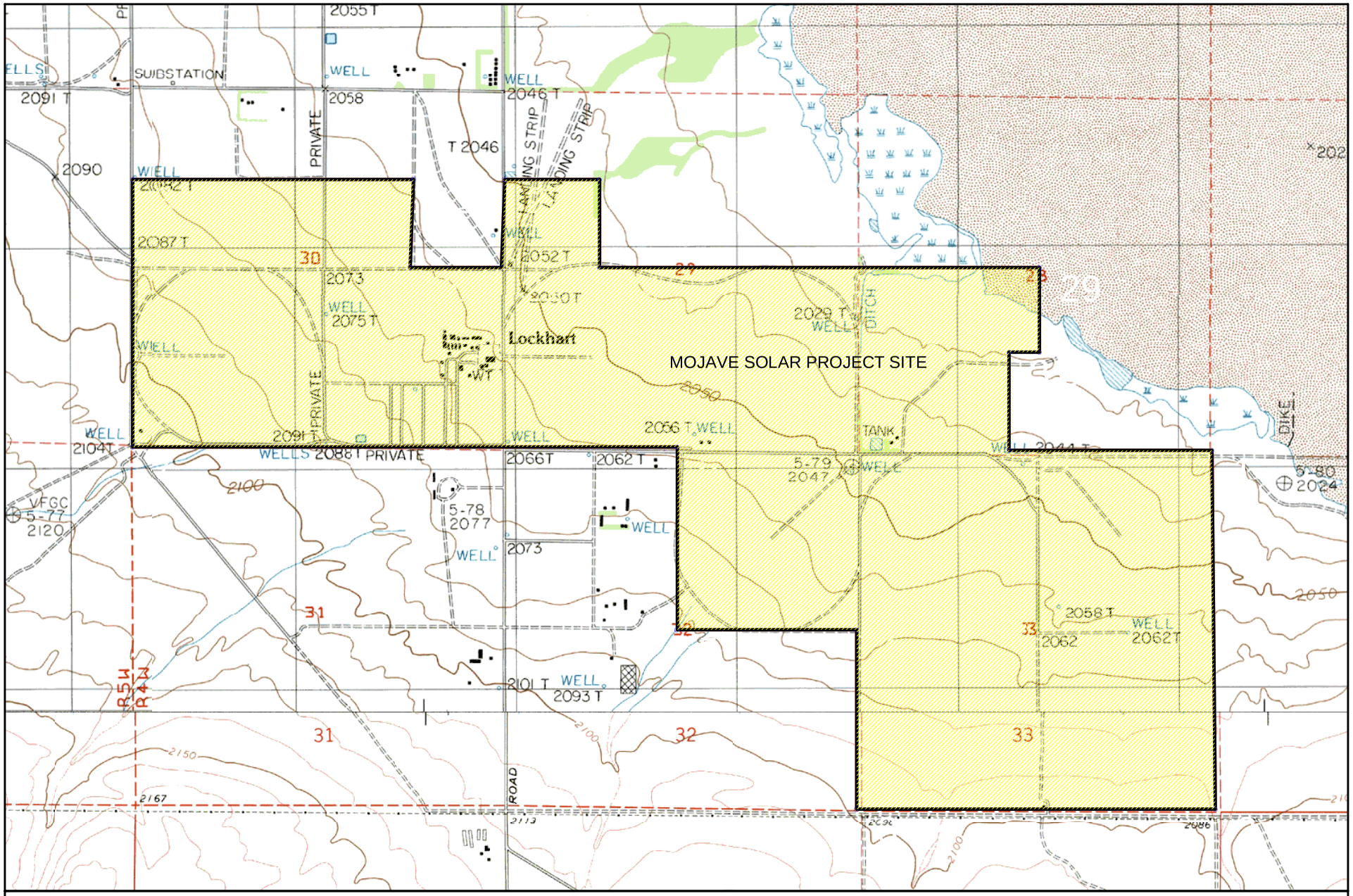
Merrell-Johnson Engineering, Inc.

PROJECT:

DATE: 07-16-2009

jcumming 11:50am 16 July 2009 P:\3001-4 Harper Lake CEC\1.0-Figure 1-1a.dwg – Figure 1-3 Site and Surrounding (2) Merrell-Johnson Engineering, Inc.

U.S.G.S. MAP



Name: LOCKHART
Date: 7/27/2009
Scale: 1 inch equals 2000 feet

Location: 035° 00' 38.83" N 117° 19' 18.48" W NAD83
Caption: MOJAVE SOLAR PROJECT SITE

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PROPOSED DEVELOPMENT PLAN

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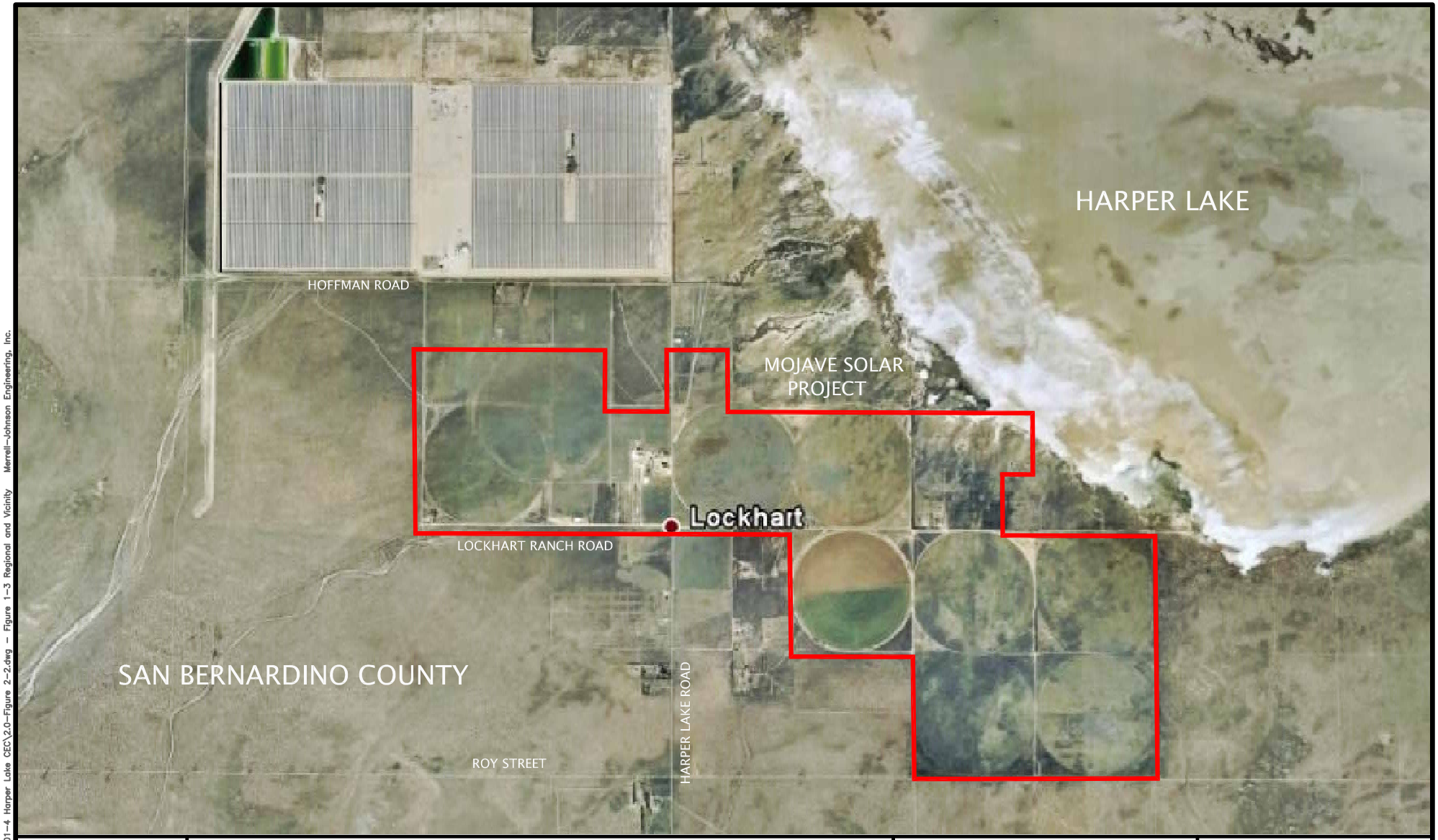
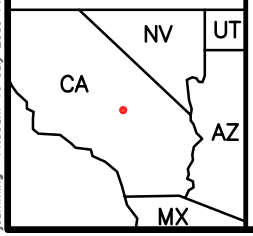


MAP LOCATION



Legend

Plant Site Boundary

0 1,500 3,000 4,500 Feet

1:36,000

MOJAVE SOLAR PROJECT

Figure 1-3
Site Map

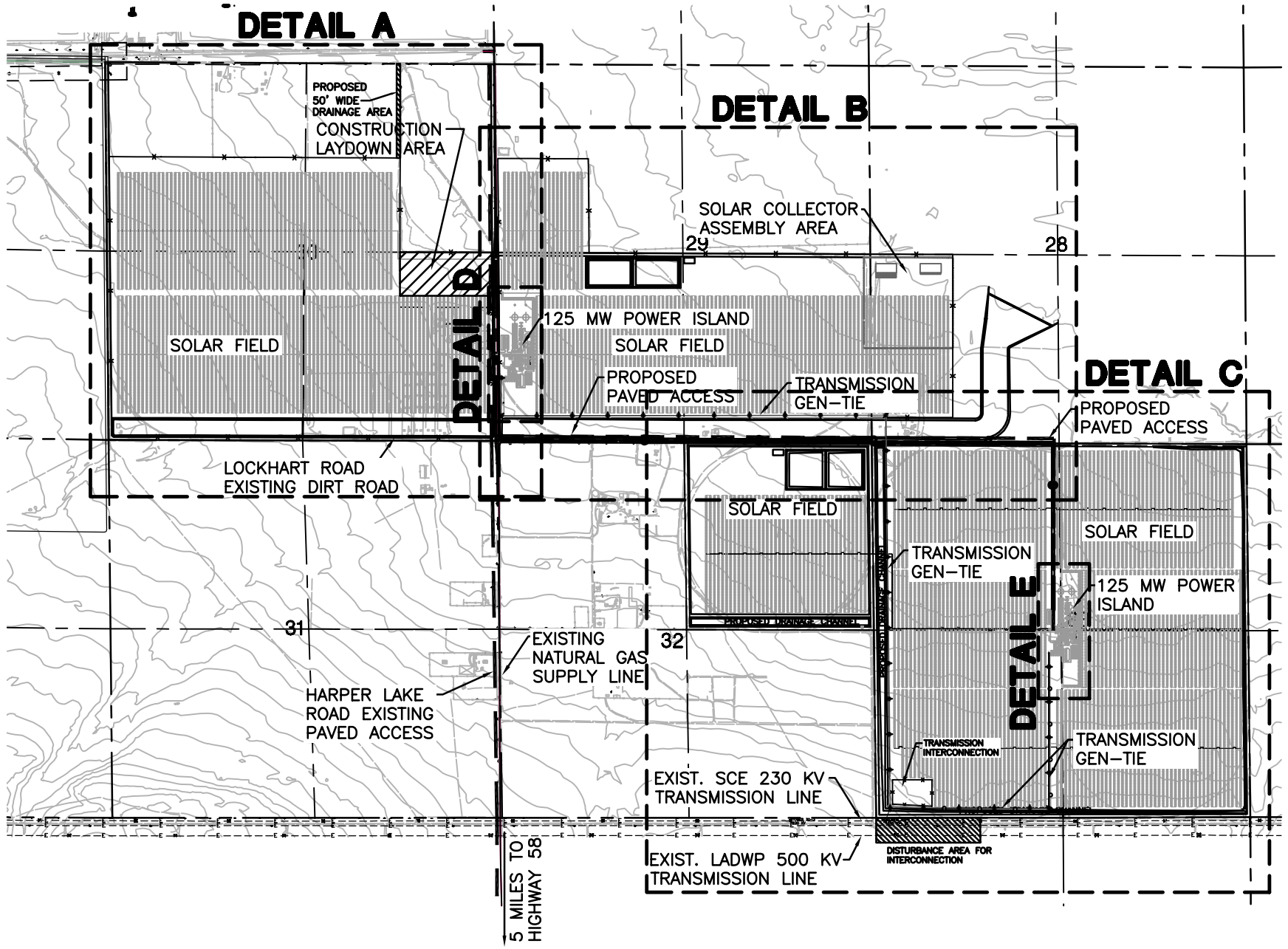
MOJAVE SOLAR LLC

Merrell-Johnson Engineering, Inc.

PROJECT:

DATE: 07-16-2009

jcumming 11:53am 16 July 2009 P:\3001-4 Harper Lake CEC\2.0-Figure 2-2.dwg - Figure 1-3 Regional and Vicinity Merrell-Johnson Engineering, Inc.



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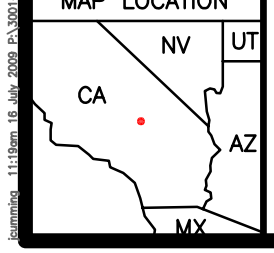


LEGEND

- PROPOSED ACCESS ROUTES
- EXISTING ACCESS ROUTES
- PROPOSED TRANSMISSION LINE
- PROPOSED GAS LINE

MOJAVE SOLAR PROJECT

Figure 2-3a
PROJECT SITE MAP

0 1000' 2000' 3000'
SCALE: 1:24000

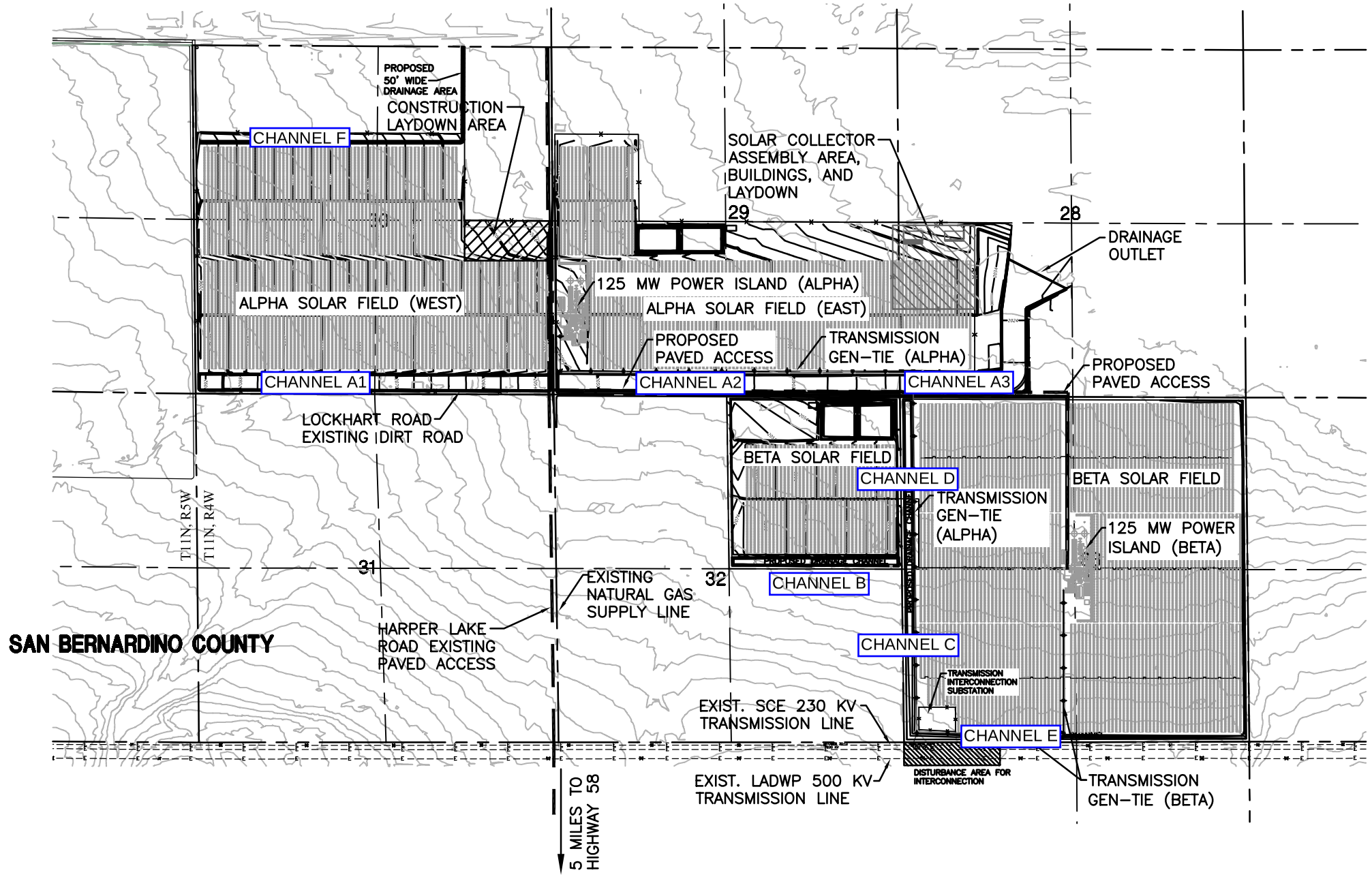
MOJAVE SOLAR LLC

Merrell-Johnson Engineering, Inc.

PROJECT:
DATE: 07/16/09

Cummins 11:19am 16 July 2009 P:\3001-4 Harper Lake CEQ\PROJECT SITE MAP.dwg – General arrangement Overall Merrell-Johnson Engineering, Inc.

DRAINAGE PLAN



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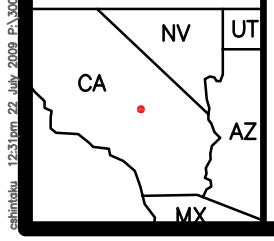


LEGEND

- PROPOSED ACCESS ROUTES
- EXISTING ACCESS ROUTES
- PROPOSED TRANSMISSION LINE
- PROPOSED GAS LINE
- PROPOSED FENCE LINE
- SECTION LINE
- 1/4 SECTION LINE

MOJAVE SOLAR PROJECT

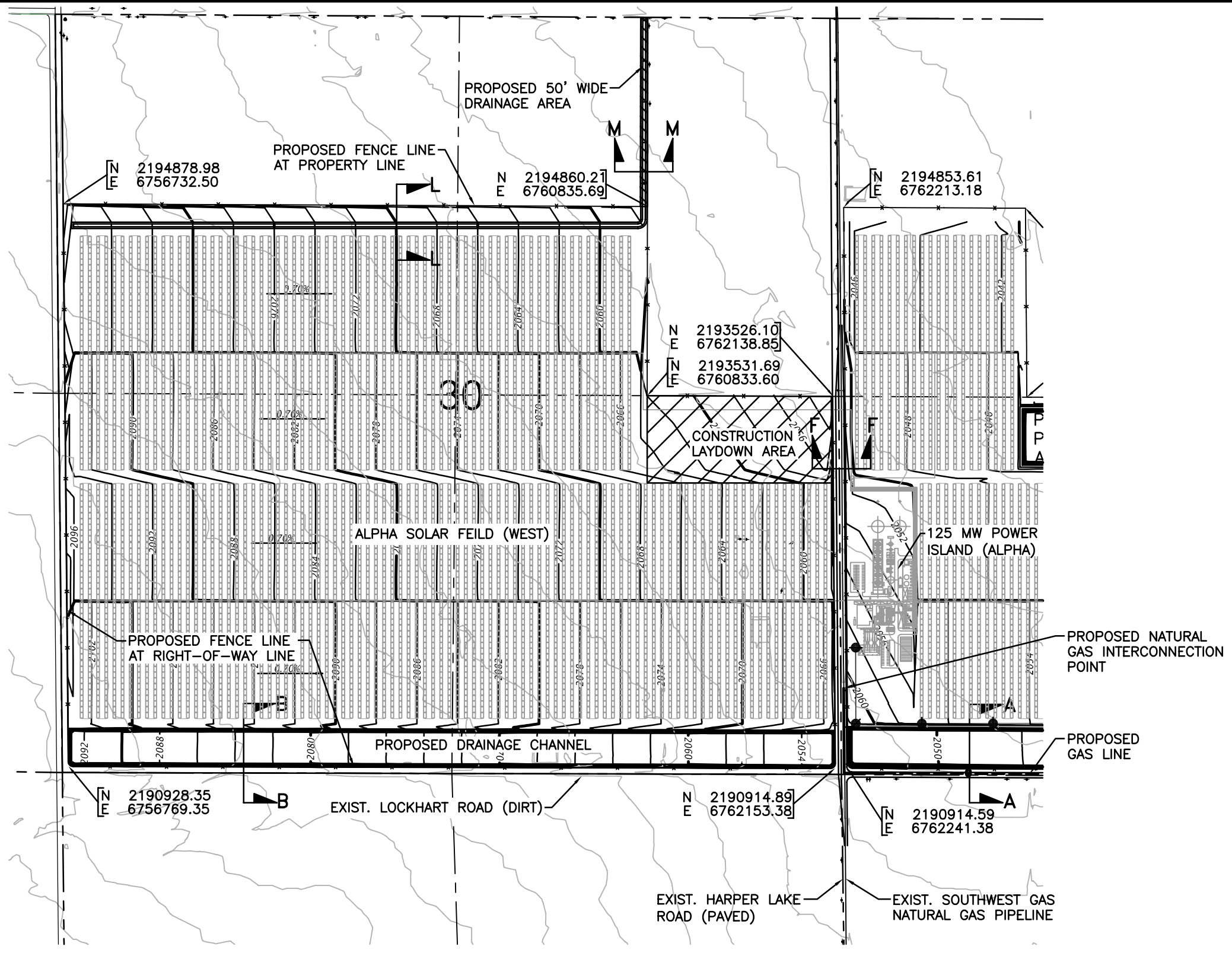
CONCEPTUAL GRADING INDEX

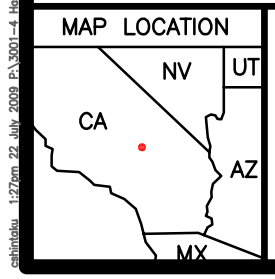
0 1000' 2000' 3000'
SCALE: 1:24000

MOJAVE SOLAR LLC

Merrell-Johnson Engineering, Inc.

PROJECT:
DATE: 07/22/09





MOJAVE SOLAR PROJECT

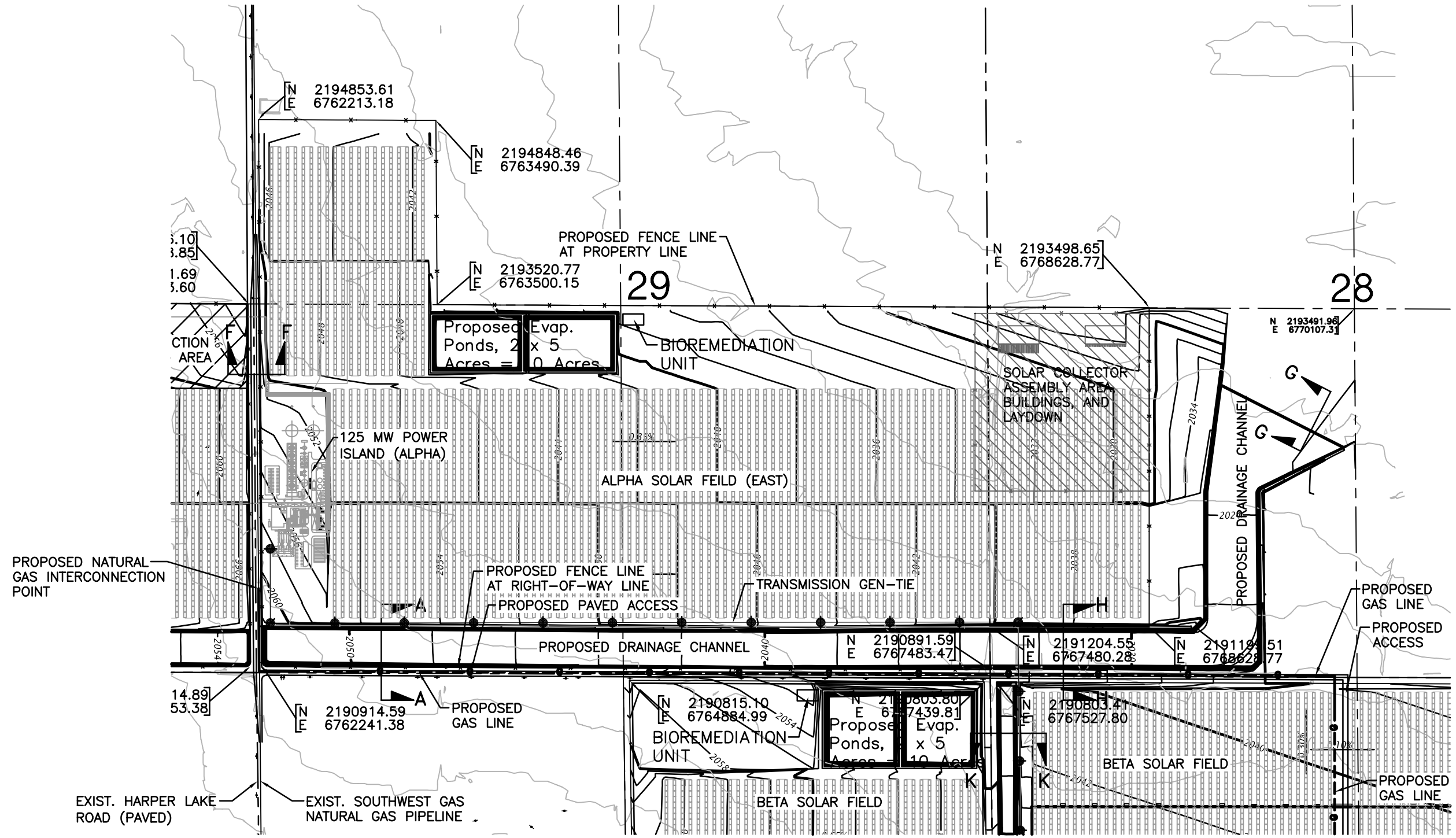
CONCEPTUAL GRADING ALPHA FIELD (WEST)

0 400' 800' 1200'
SCALE: 1" = 800'

MOJAVE SOLAR LLC

Merrell-Johnson Engineering, Inc.

PROJECT:
DATE: 07/22/09



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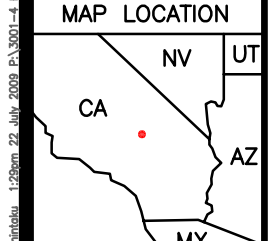


MOJAVE SOLAR PROJECT

CONCEPTUAL GRADING
ALPHA FIELD (EAST)

0 400' 800' 1200'
SCALE: 1" = 800'

MOJAVE SOLAR LLC

Merrell-Johnson Engineering, Inc.

PROJECT:
DATE: 07/22/09

PROPOSED DRAINAGE CHANNEL

N 2190891.59
E 6767483.47

N 2191204.55
E 6767480.28

N 2191189.51
E 6768628.77

PROPOSED PAVED ACCESS

N 2190815.10
E 6764884.99

BIOREMEDIATION UNIT

N 2190803.80
E 6767439.81

Proposed Evap. Ponds, x 5
Acres = 10 Acres

N 2190803.41
E 6767527.80

PROPOSED FENCE LINE AT RIGHT-OF-WAY LINE

N 2190780.61
E 6772725.31

PROPOSED GAS LINE

BETA SOLAR FEILD

TRANSMISSION GEN-TIE FROM ALPHA

BETA SOLAR FEILD

PROPOSED FENCE LINE AT RIGHT-OF-WAY LINE

125 MW POWER ISLAND (BETA)

PROPOSED DRAINAGE CHANNEL

PROPOSED DRAINAGE CHANNEL

32

N 2188252.64
E 6764918.31

N 2188247.65
E 6767470.55

TRANSMISSION INTERCONNECTION SUBSTATION

TRANSMISSION GEN-TIE FROM BETA

N 2185600.08
E 6767590.38

EXIST. SCE 230 KV TRANSMISSION LINE

PROPOSED FENCE LINE AT RIGHT-OF-WAY LINE

N 2185609.42
E 6772777.47

TOWER 30-3 230 KV

TOWER 30-2 230 KV

EXIST. LADWP 500 KV TRANSMISSION LINE

DISTURBANCE AREA FOR INTERCONNECTION

MAP LOCATION

NV UT CA AZ MX

MOJAVE SOLAR PROJECT

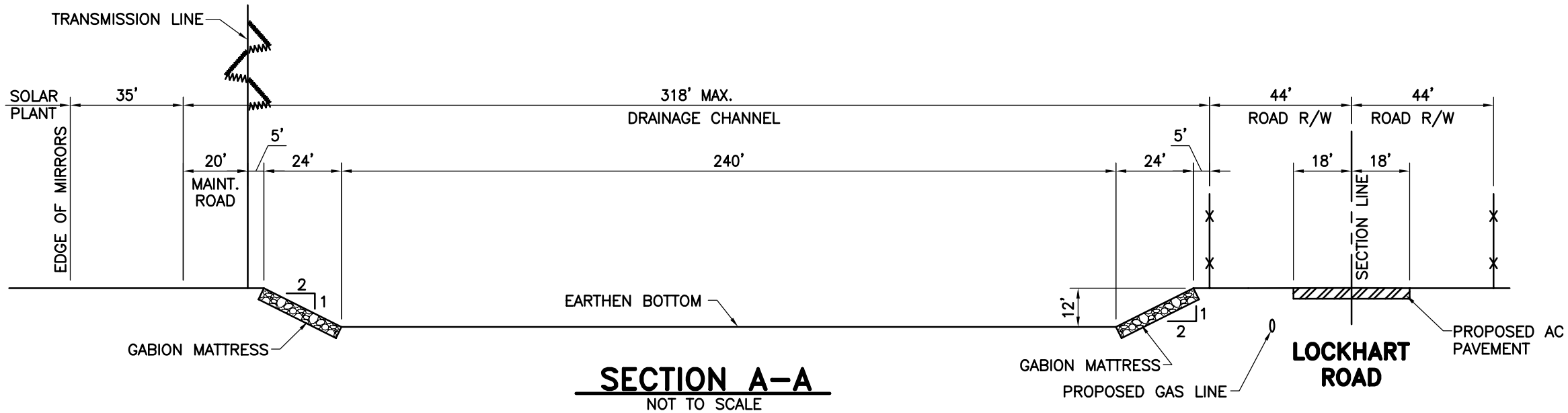
CONCEPTUAL GRADING BETA FIELD

0 400' 800' 1200'
SCALE: 1" = 800'

MOJAVE SOLAR LLC

Merrell-Johnson Engineering, Inc.

PROJECT:
DATE: 07/22/09



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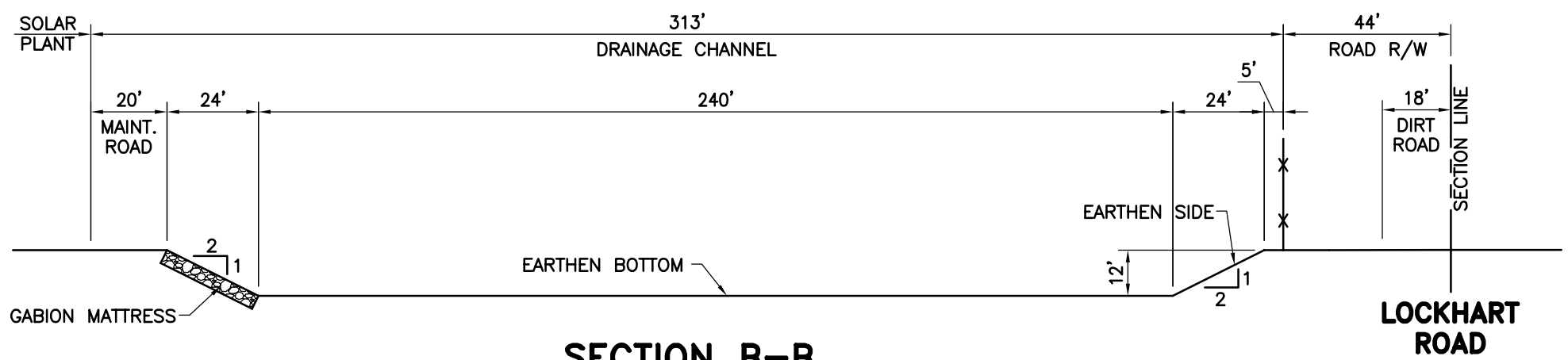

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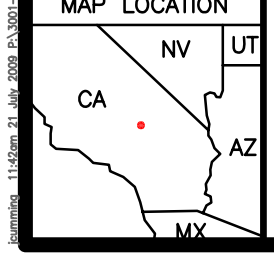

MOJAVE SOLAR PROJECT

Figure 2-3(g)
SECTIONS

MOJAVE SOLAR LLC

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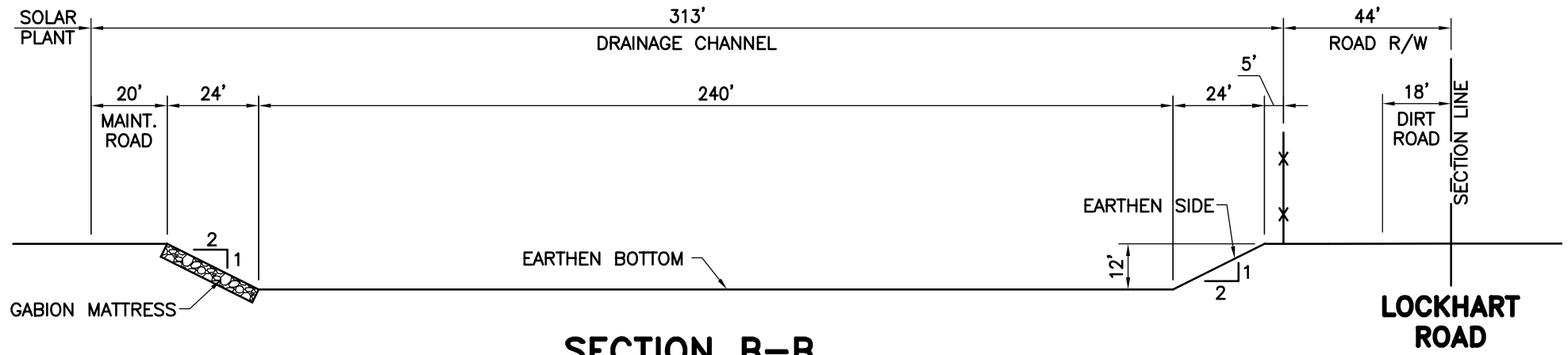
PROJECT:
DATE: 07/21/09



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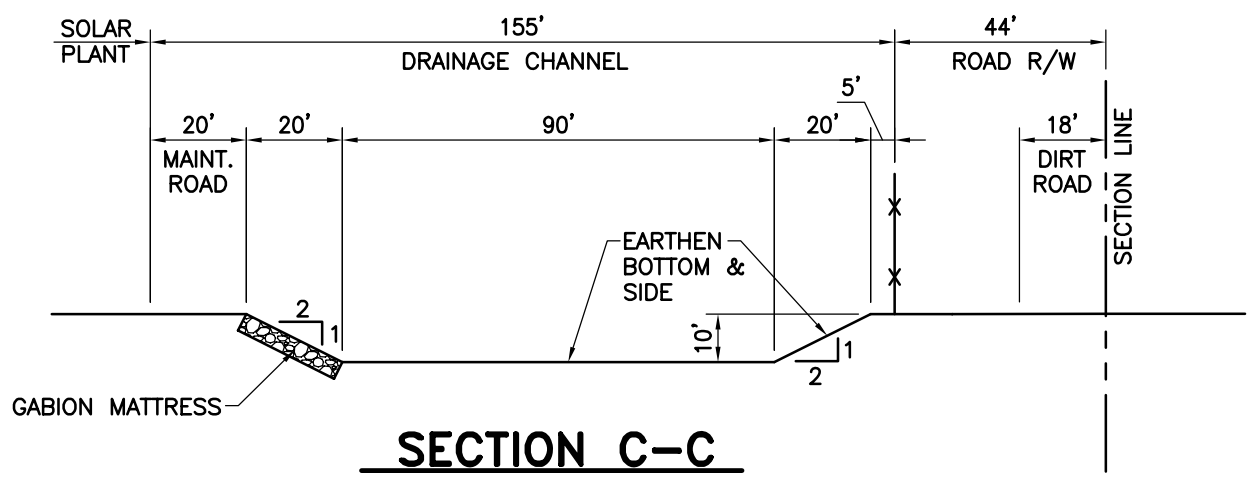

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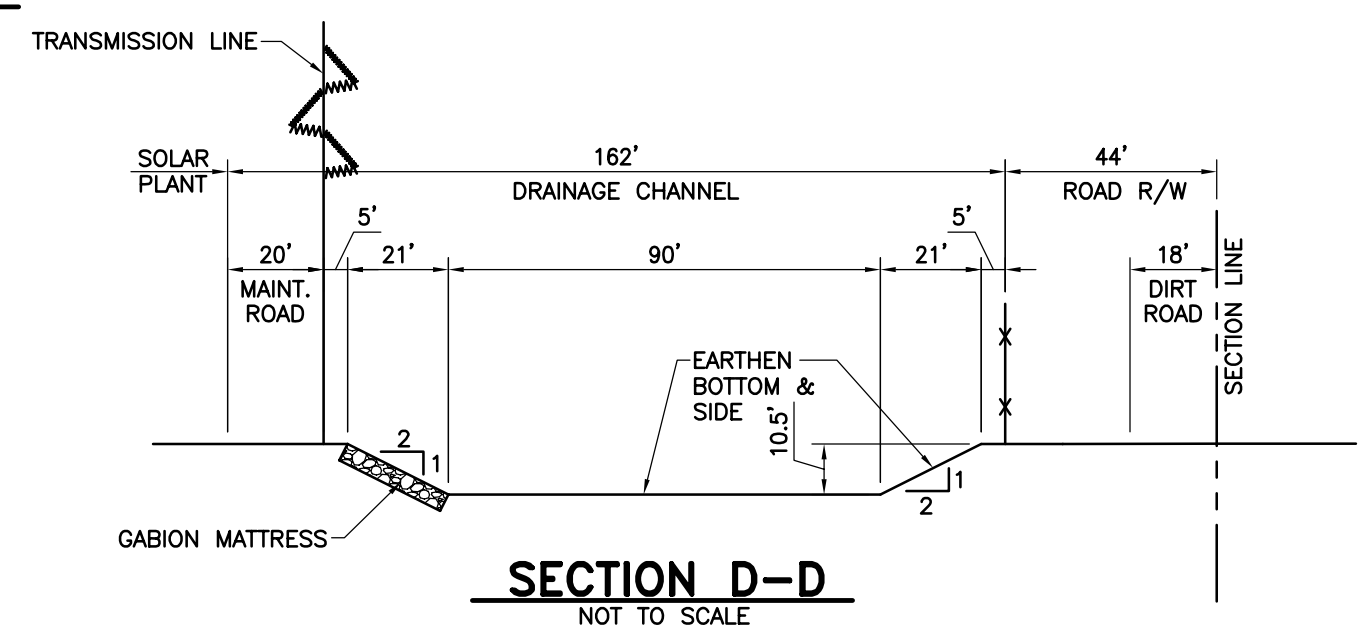

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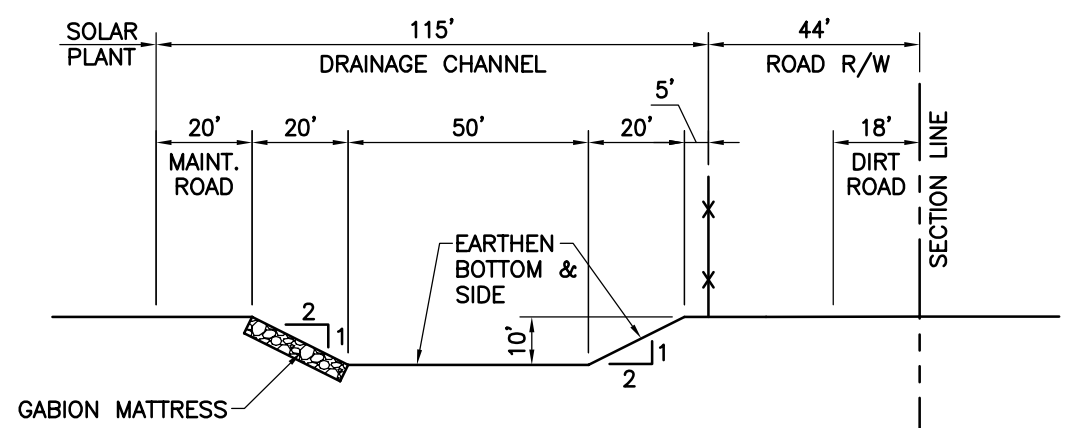

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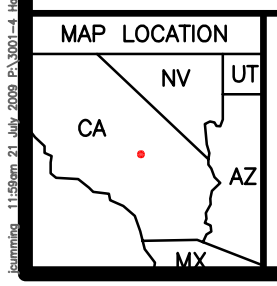

MOJAVE SOLAR PROJECT

Figure 2-3(h)
SECTIONS

MOJAVE SOLAR LLC

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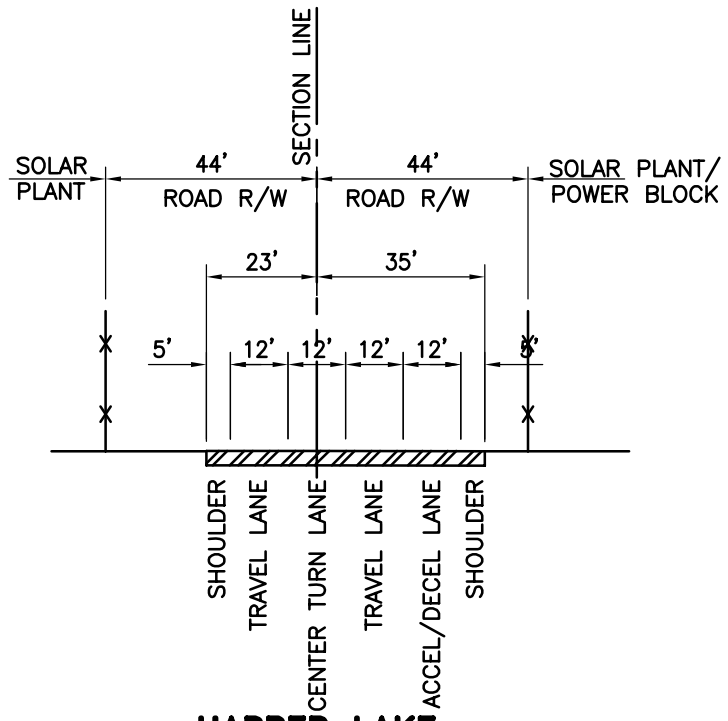
PROJECT:

DATE: 07/21/09

Cummins 11:59am 21 July 2009 P:\3001-4 Hopper Lake CEQA\PROJECT SITE MAP.dwg – Channel detail h Merrell-Johnson Engineering, Inc.



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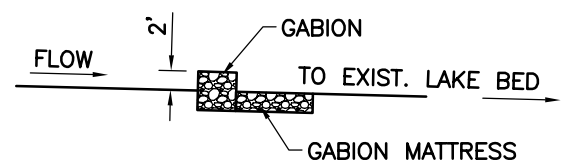

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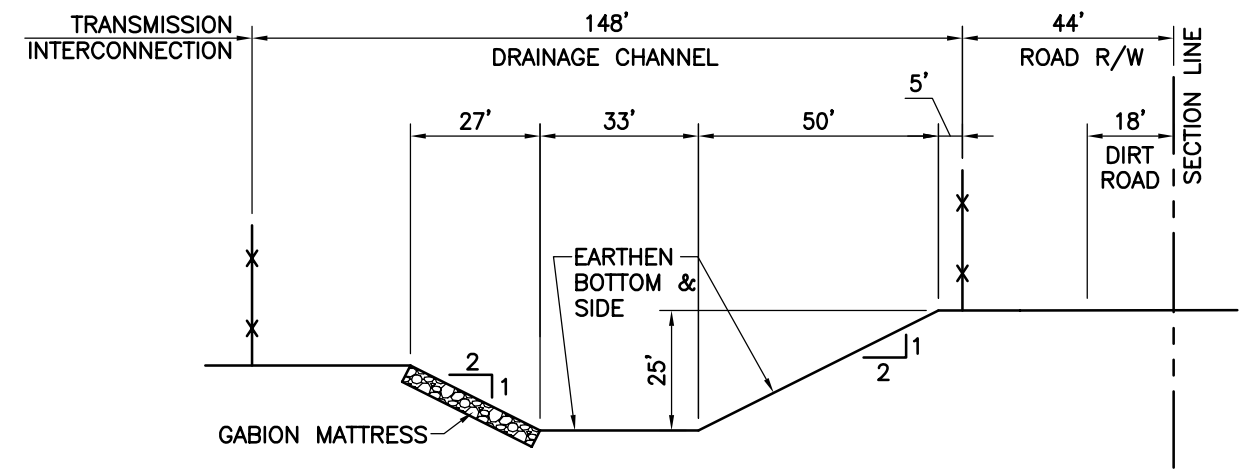

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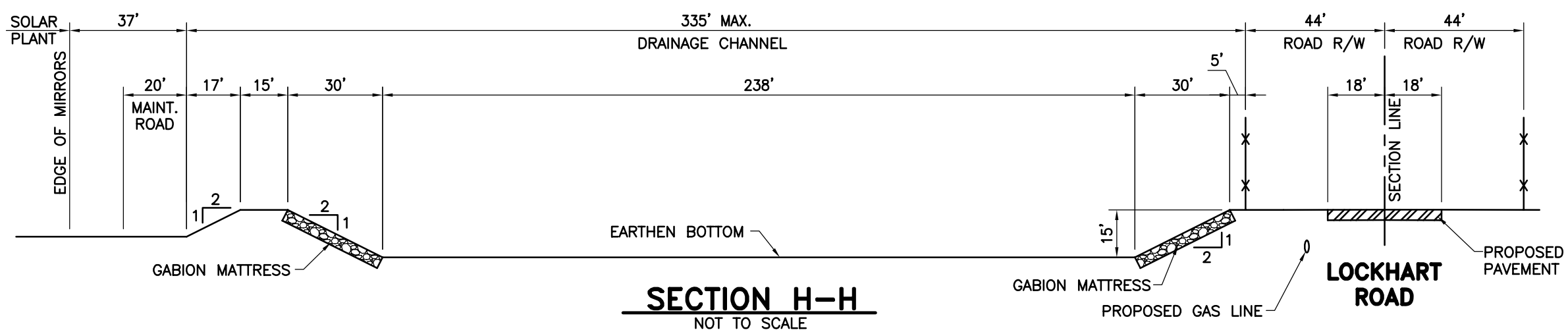

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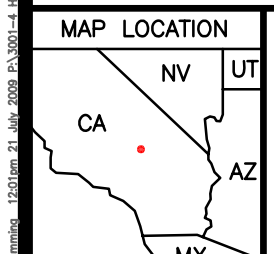
MAP LOCATION



MOJAVE SOLAR PROJECT

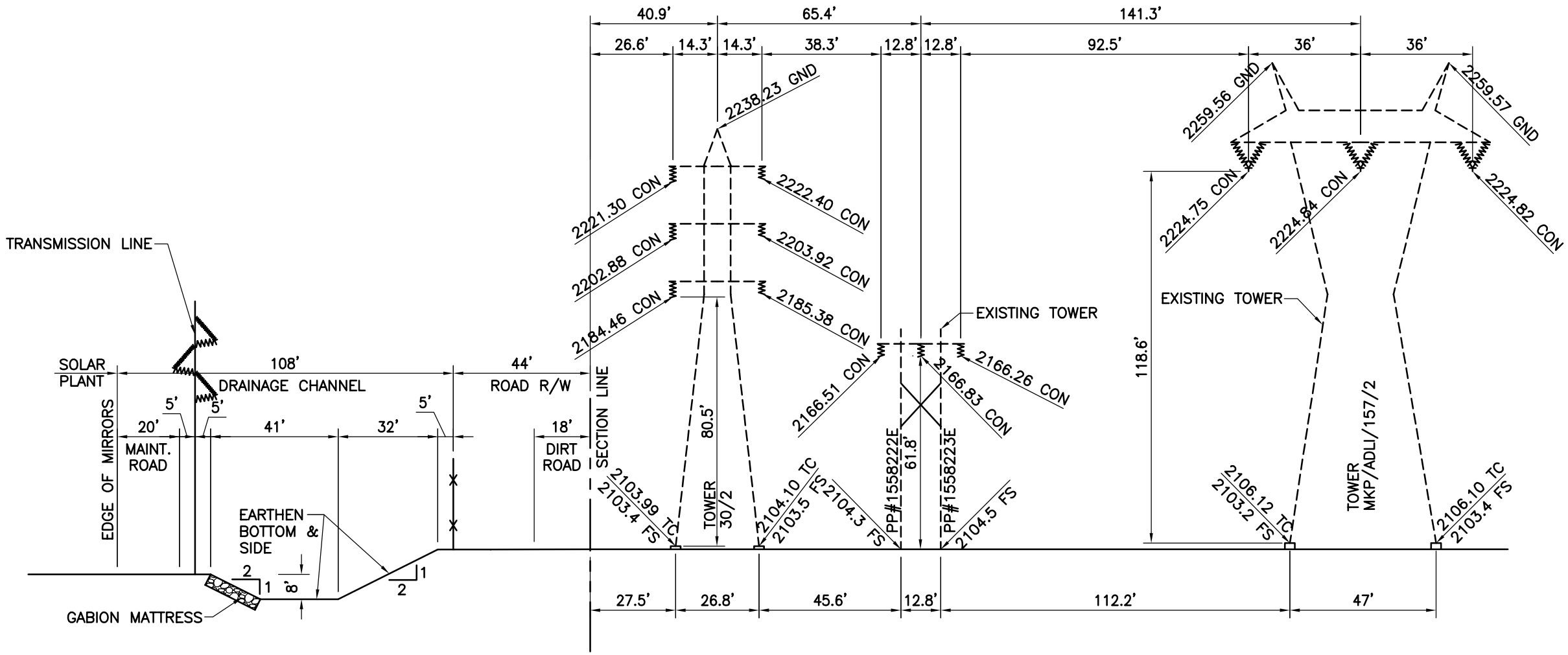
Figure 2-3(i)
SECTIONS

MOJAVE SOLAR LLC

Merrell-Johnson Engineering, Inc.

PROJECT:
DATE: 07/21/09

Cummins 12:01pm 21 July 2009 P:\3001-4 Harper Lake CEQ\PROJECT SITE MAP.dwg - Channel detail I Merrell-Johnson Engineering, Inc.



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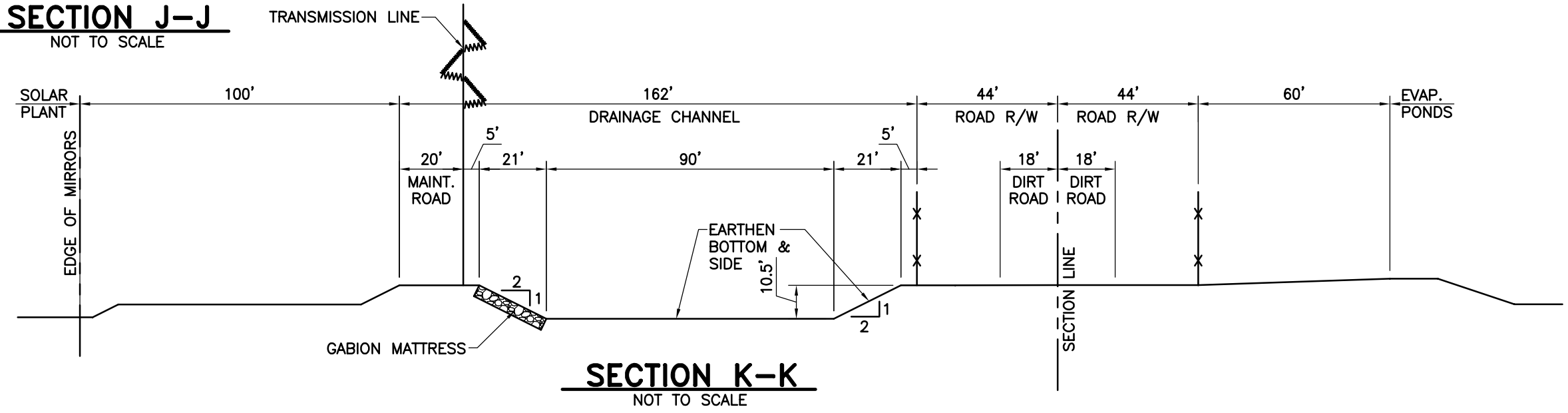

SECTION K–K

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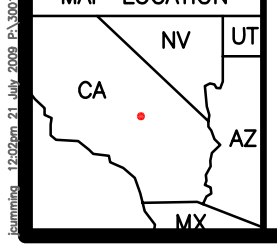
MAP LOCATION



MOJAVE SOLAR PROJECT

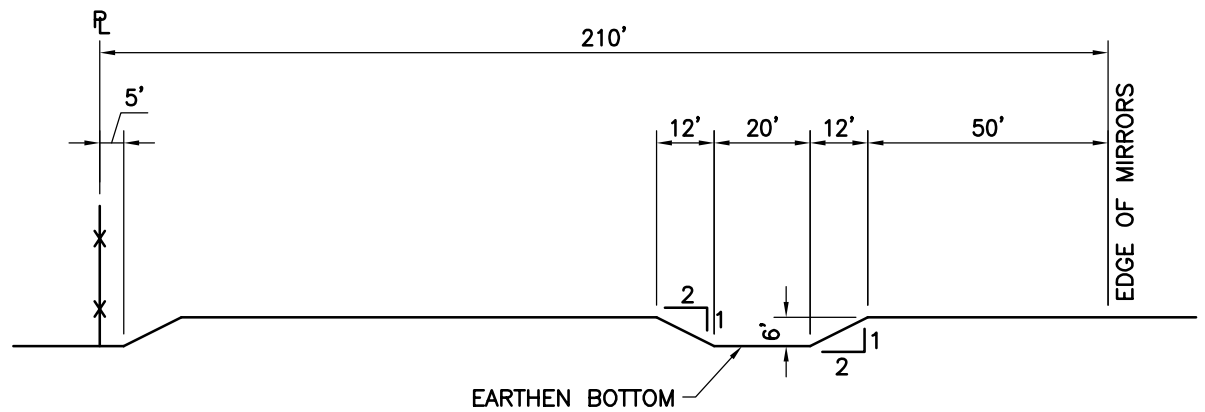
Figure 2-3(j)
SECTIONS

MOJAVE SOLAR LLC

Merrell-Johnson Engineering, Inc.

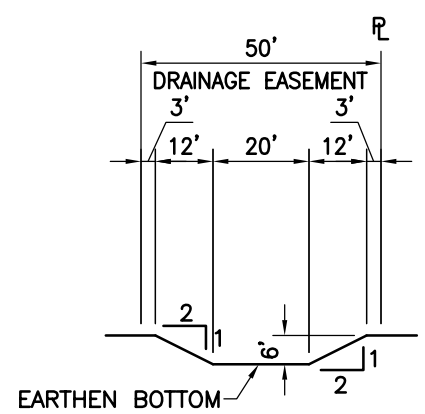
PROJECT:

DATE: 07/21/09



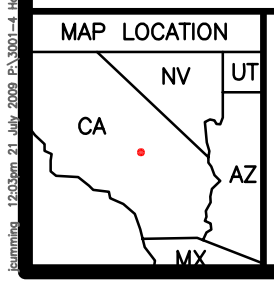
SECTION L–L

NOT TO SCALE



SECTION M–M

NOT TO SCALE



MOJAVE SOLAR PROJECT

Figure 2-3(k)
SECTIONS

MOJAVE SOLAR LLC

Merrell-Johnson Engineering, Inc.

PROJECT:
DATE: 07/21/09

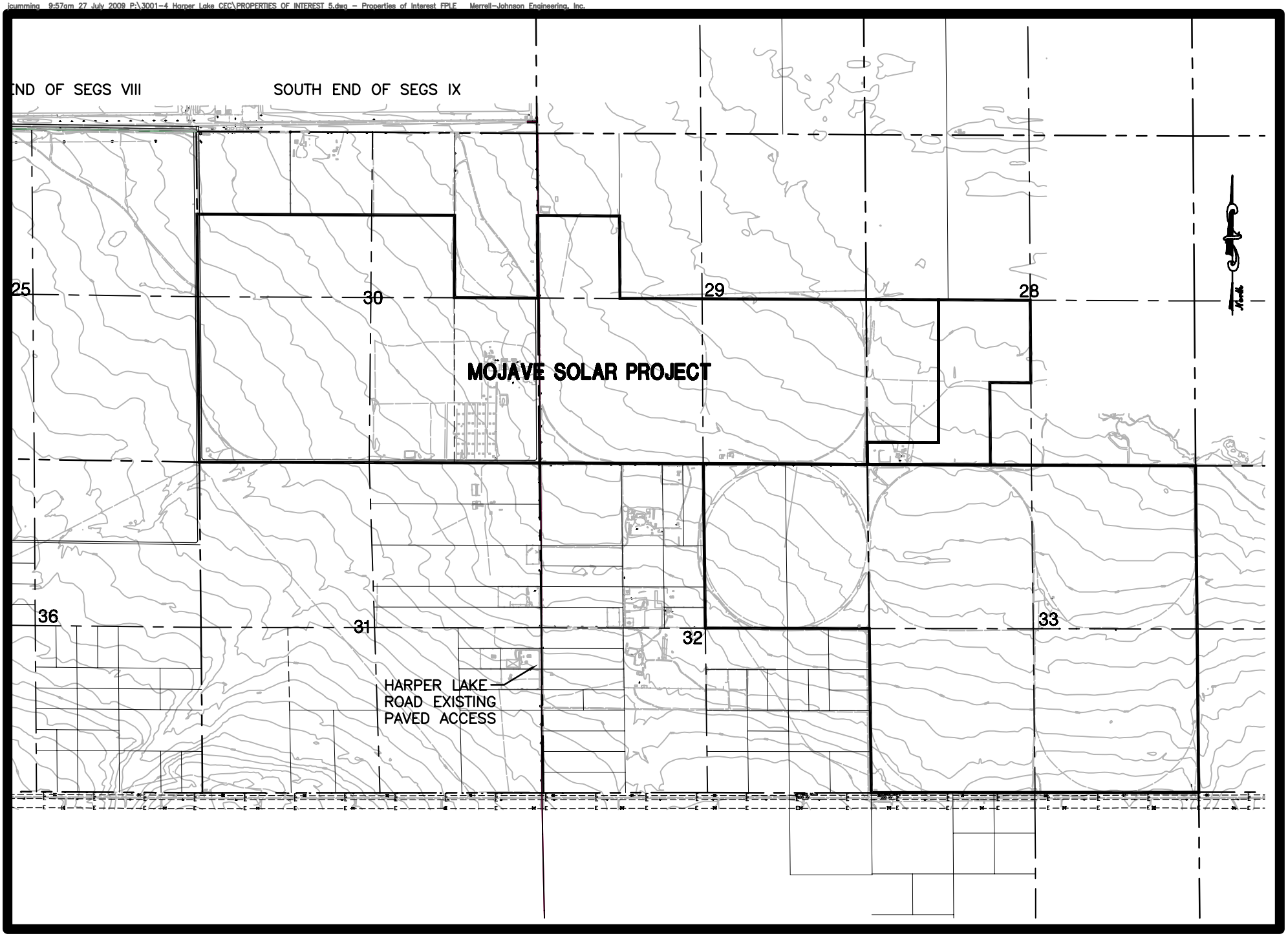
Cummins 12:03pm 21 July 2009 P:\3001-4 Harper Lake CEC\PROJECT SITE MAP.dwg - Channel detail k Merrell-Johnson Engineering, Inc.

SECTION 3

HYDROLOGY CALCULATIONS

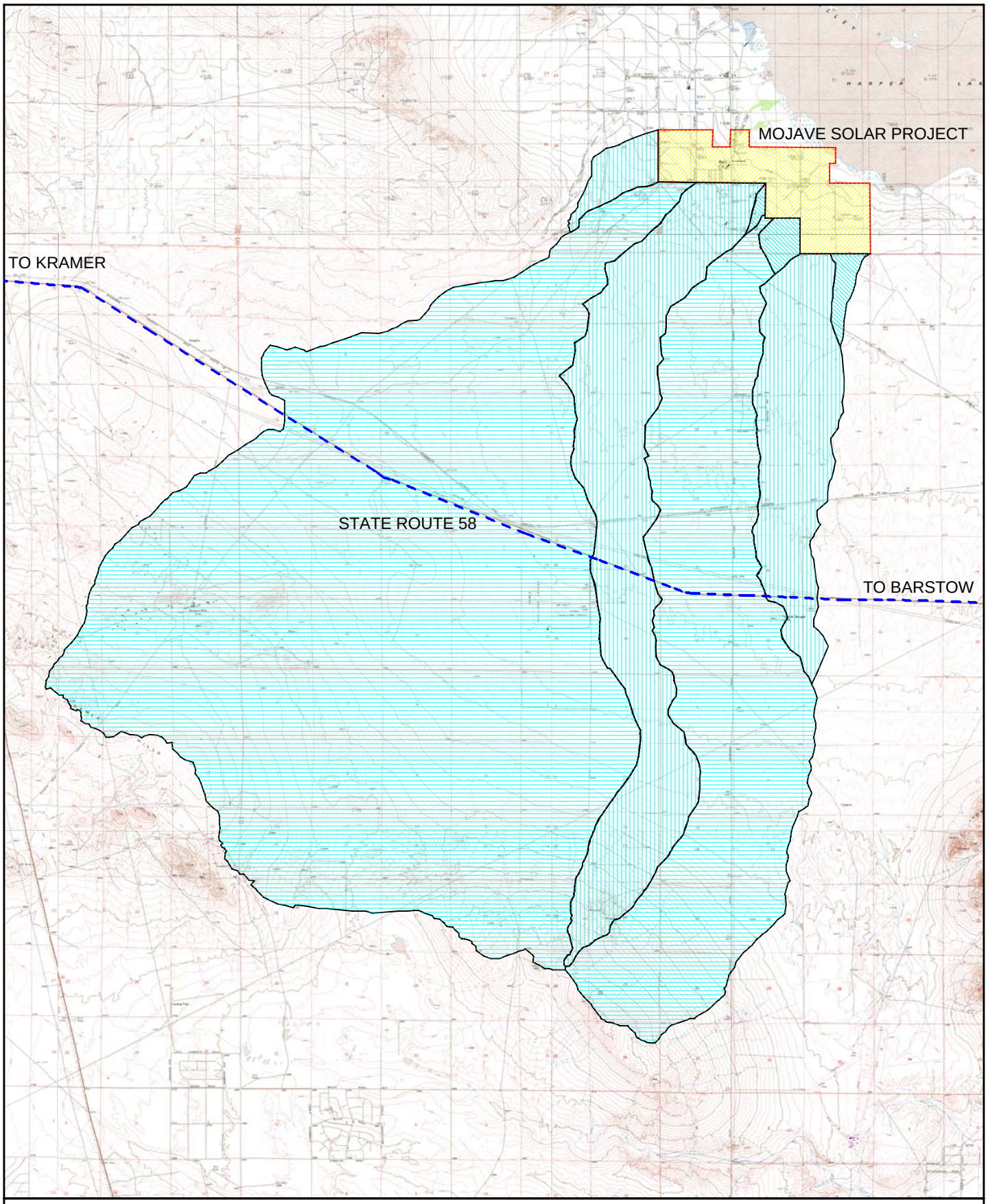
Merrell-Johnson Engineering, Inc.
CIVIL ENGINEERING ♦ SURVEYING

TOPOGRAPHY MAP


END OF SEGS VIII
SOUTH END OF SEGS IX
25
30
29
28
MOJAVE SOLAR PROJECT
36
31
32
33
HARPER LAKE
ROAD EXISTING
PAVED ACCESS

OFF-SITE HYDROLOGY CALCULATIONS

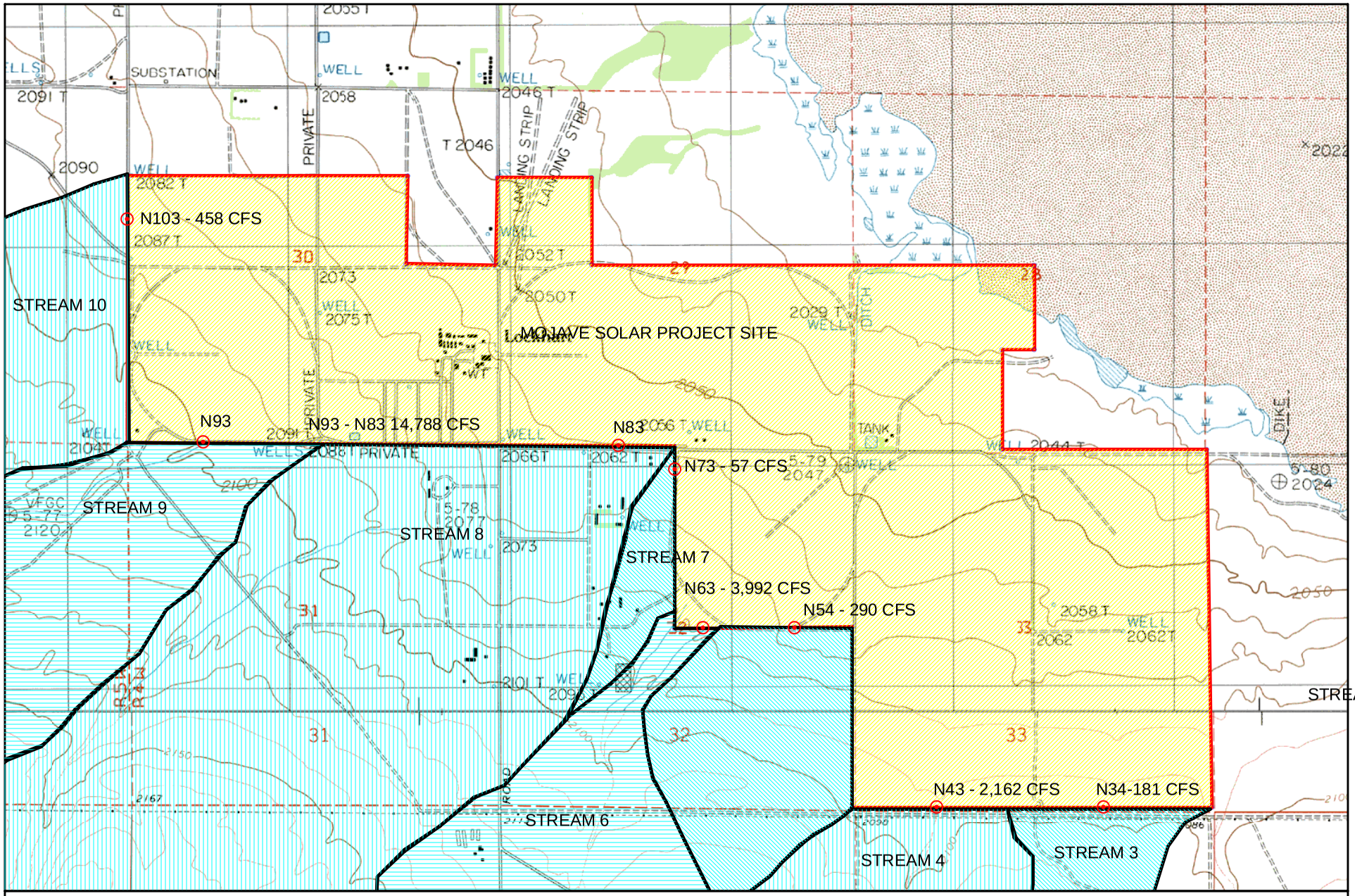
OFF-SITE HYDROLOGY MAP



Name: KRAMER HILLS
Date: 6/22/2009
Scale: 1 inch equals 1.894 miles

Location: Sec 34 T010N R005W CA San Bernardino
Caption: MOJAVE SOLAR PROJECT - OFF-SITE TRIBUTARY AREAS

Copyright (C) 1997, Maptech, Inc.



Name: LOCKHART
Date: 6/22/2009
Scale: 1 inch equals 2000 feet

Location: Sec 29 T011N R004W CA San Bernardino
Caption: MOJAVE SOLAR PROJECT - OFF-SITE TRIBUTARY FLOWS

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UNIT HYDROGRAPH AND RATIONAL CALCULATIONS

100-YEAR STORM

Merrell-Johnson Engineering, Inc.
CIVIL ENGINEERING ♦ SURVEYING

STREAM 3

San Bernardino County Rational Hydrology Program

(Hydrology Manual Date - August 1986)

CIVILCADD/CIVILDESIGN Engineering Software, (c) 1989-2004 Version 7.0
Rational Hydrology Study Date: 04/11/08

ABENGOA SOLAR - HARPER LAKE - JOB 3001
SOUTHERN TRIBUTARY AREA - STREAM 3
NODE 31 - NODE 34
100-YEAR STORM EVENT - AMC II

MERRELL-JOHNSON ENGINEERING, INC.
12138 INDUSTRIAL BOULEVARD, SUITE 240
VICTORVILLE, CA 92395
(760) 241-6146 * FAX (760) 241-0566

********* Hydrology Study Control Information **********

Rational hydrology study storm event year is 100.0
Computed rainfall intensity:
Storm year = 100.00 1 hour rainfall = 1.200 (In.)
Slope used for rainfall intensity curve b = 0.7000
Soil antecedent moisture condition (AMC) = 2

++
Process from Point/Station 31.000 to Point/Station 32.000
**** INITIAL AREA EVALUATION ****

UNDEVELOPED (poor cover) subarea
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2) = 86.00
Pervious ratio(Ap) = 1.0000 Max loss rate(Fm)= 0.265(In/Hr)
Initial subarea data:
Initial area flow distance = 989.000(Ft.)
Top (of initial area) elevation = 2161.000(Ft.)
Bottom (of initial area) elevation = 2150.000(Ft.)
Difference in elevation = 11.000(Ft.)
Slope = 0.01112 s(%)= 1.11
TC = k(0.525)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration = 20.370 min.
Rainfall intensity = 2.556(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.807
Subarea runoff = 9.691(CFS)
Total initial stream area = 4.700(Ac.)
Pervious area fraction = 1.000
Initial area Fm value = 0.265(In/Hr)

++
Process from Point/Station 32.000 to Point/Station 33.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****

Depth of flow = 0.715(Ft.), Average velocity = 1.896(Ft/s)

```
      ******* Irregular Channel Data ***********
-----------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
      1              0.00              1.00
      2             10.00              0.00
      3             20.00              1.00
Manning's 'N' friction factor =   0.035
-----------------------------------------------------------------
Sub-Channel flow  =      9.691(CFS)
  '     '    flow top width =     14.297(Ft.)
  '     '    velocity=    1.896(Ft/s)
  '     '    area =      5.110(Sq.Ft)
  '     '    Froude number =     0.559

Upstream point elevation =  2150.000(Ft.)
Downstream point elevation =  2130.000(Ft.)
Flow length =  2526.000(Ft.)
Travel time  =   22.20 min.
Time of concentration =   42.57 min.
Depth of flow =   0.715(Ft.)
Average velocity =   1.896(Ft/s)
Total irregular channel flow =     9.691(CFS)
Irregular channel normal depth above invert elev. =   0.715(Ft.)
Average velocity of channel(s) =   1.896(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       32.000 to Point/Station       33.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
UNDEVELOPED (poor cover) subarea
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 86.00
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.265(In/Hr)
Time of concentration =    42.57 min.
Rainfall intensity =      1.526(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.744
Subarea runoff =     57.823(CFS) for   54.800(Ac.)
Total runoff =     67.514(CFS)
Effective area this stream =       59.50(Ac.)
Total Study Area (Main Stream No. 1) =       59.50(Ac.)
Area averaged Fm value =    0.265(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       33.000 to Point/Station       34.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
______________________________________________________________________
Depth of flow =   1.386(Ft.), Average velocity =   4.008(Ft/s)
      ******* Irregular Channel Data ***********
-----------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
      1              0.00              2.00
      2              6.00              0.00
```

```
      3             14.00              0.00
      4             20.00              2.00
Manning's 'N' friction factor =   0.035
----------------------------------------------------------------
Sub-Channel flow  =     67.514(CFS)
  '     '    flow top width =     16.314(Ft.)
  '     '    velocity=    4.008(Ft/s)
  '     '    area =     16.846(Sq.Ft)
  '     '    Froude number =     0.695

Upstream point elevation =  2130.000(Ft.)
Downstream point elevation =  2096.000(Ft.)
Flow length =  3841.000(Ft.)
Travel time  =   15.97 min.
Time of concentration =   58.54 min.
Depth of flow =   1.386(Ft.)
Average velocity =   4.008(Ft/s)
Total irregular channel flow =    67.514(CFS)
Irregular channel normal depth above invert elev. =   1.386(Ft.)
Average velocity of channel(s) =   4.008(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       33.000 to Point/Station       34.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
UNDEVELOPED (poor cover) subarea
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 86.00
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.265(In/Hr)
Time of concentration =    58.54 min. Tc
Rainfall intensity =      1.221(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.705
Subarea runoff =    113.547(CFS) for  151.000(Ac.)
Total runoff =    181.061(CFS) Q100
Effective area this stream =      210.50(Ac.)
Total Study Area (Main Stream No. 1) =      210.50(Ac.)
Area averaged Fm value =    0.265(In/Hr)
End of computations, Total Study Area =          210.50 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.
Note: These figures do not consider reduced effective area
effects caused by confluences in the rational equation.

Area averaged pervious area fraction(Ap) = 1.000
Area averaged SCS curve number =  86.0
```

STREAM 4

U n i t H y d r o g r a p h A n a l y s i s

Copyright (c) CIVILCADD/CIVILDESIGN, 1989 - 2004, Version 7.0

Study date 04/11/08

++

San Bernardino County Synthetic Unit Hydrology Method
Manual date - August 1986

MERRELL-JOHNSON ENGINEERING, INC.
12138 INDUSTRIAL BOULEVARD, SUITE 240
VICTORVILLE, CA 92395
(760) 241-6146 * FAX (760) 241-0566

ABENGOA SOLAR - HARPER LAKE - JOB NO. 3001
SOUTHERN TRIBUTARY AREA - STREAM 4
100-YEAR STORM EVENT - AMC II

Storm Event Year = 100

Antecedent Moisture Condition = 2

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

English Units used in output format

Area averaged rainfall intensity isohyetal data:

Sub-Area (Ac.)	Duration (hours)	Isohyetal (In)
Rainfall data for year 100		
3520.00	1	1.20
Rainfall data for year 100		
3520.00	6	1.80
Rainfall data for year 100		
3520.00	24	3.00

++

******** Area-averaged max loss rate, Fm ********

SCS curve No.(AMCII)	SCS curve NO.(AMC 2)	Area (Ac.)	Area Fraction	Fp(Fig C6) (In/Hr)	Ap (dec.)	Fm (In/Hr)
84.0	84.0	3520.00	1.000	0.301	1.000	0.301

Area-averaged adjusted loss rate Fm (In/Hr) = 0.301

********* Area-Averaged low loss rate fraction, Yb **********

Area (Ac.)	Area Fract	SCS CN (AMC2)	SCS CN (AMC2)	S	Pervious Yield Fr
3520.00	1.000	84.0	84.0	1.90	0.505

Area-averaged catchment yield fraction, Y = 0.505
Area-averaged low loss fraction, Yb = 0.495
++
Watercourse length = 35535.00(Ft.)
Length from concentration point to centroid = 14679.00(Ft.)
Elevation difference along watercourse = 218.00(Ft.)
Mannings friction factor along watercourse = 0.030
Watershed area = 3520.00(Ac.)
Catchment Lag time = 1.132 hours
Unit interval = 10.000 minutes
Unit interval percentage of lag time = 14.7267
Hydrograph baseflow = 0.00(CFS)
Average maximum watershed loss rate(Fm) = 0.301(In/Hr)
Average low loss rate fraction (Yb) = 0.495 (decimal)
DESERT S-Graph Selected
Computed peak 5-minute rainfall = 0.569(In)
Computed peak 30-minute rainfall = 0.975(In)
Specified peak 1-hour rainfall = 1.200(In)
Computed peak 3-hour rainfall = 1.539(In)
Specified peak 6-hour rainfall = 1.800(In)
Specified peak 24-hour rainfall = 3.000(In)

Rainfall depth area reduction factors:
Using a total area of 3520.00(Ac.) (Ref: fig. E-4)

5-minute factor = 0.840 Adjusted rainfall = 0.478(In)
30-minute factor = 0.840 Adjusted rainfall = 0.818(In)
1-hour factor = 0.840 Adjusted rainfall = 1.007(In)
3-hour factor = 0.979 Adjusted rainfall = 1.507(In)
6-hour factor = 0.989 Adjusted rainfall = 1.781(In)
24-hour factor = 0.996 Adjusted rainfall = 2.987(In)

U n i t H y d r o g r a p h
++

Interval Number	'S' Graph Mean values	Unit Hydrograph ((CFS))
	(K = 21285.00 (CFS))	
1	0.661	140.788
2	2.765	447.744
3	6.264	744.740
4	11.837	1186.333
5	22.529	2275.715
6	36.417	2956.120
7	47.224	2300.270
8	55.304	1719.720
9	61.229	1261.175
10	65.795	971.767
11	69.605	811.112
12	72.869	694.624

13	75.595	580.198
14	78.054	523.410
15	80.087	432.795
16	81.939	394.175
17	83.543	341.438
18	85.041	318.833
19	86.442	298.247
20	87.674	262.142
21	88.794	238.370
22	89.697	192.392
23	90.556	182.638
24	91.377	174.882
25	92.119	157.823
26	92.817	148.658
27	93.471	139.271
28	94.068	126.902
29	94.570	106.985
30	95.071	106.576
31	95.560	104.112
32	95.961	85.385
33	96.344	81.499
34	96.727	81.470
35	97.045	67.783
36	97.310	56.423
37	97.575	56.423
38	97.815	51.077
39	97.970	32.856
40	98.117	31.346
41	98.265	31.554
42	98.434	35.888
43	98.611	37.615
44	98.787	37.615
45	98.964	37.615
46	99.141	37.615
47	99.318	37.615
48	99.485	35.646
49	99.589	22.148
50	99.681	19.591
51	99.773	19.591
52	99.865	19.591
53	100.000	9.796

Total soil rain loss = 1.22(In)
Total effective rainfall = 1.77(In)
Peak flow rate in flood hydrograph = 2162.03(CFS)

++

24 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 10 Minute intervals ((CFS))

```
Time(h+m) Volume Ac.Ft   Q(CFS)  0      550.0    1100.0    1650.0    2200.0
-----------------------------------------------------------------------
 15+ 0     138.2017    243.44  |   Q     V         |         |         |
 15+10     141.9069    268.99  |   Q     V         |         |         |
 15+20     145.9632    294.49  |    Q    |V        |         |         |
```

```
15+30     150.3788    320.57  |    Q    |V        |         |         |
15+40     155.1809    348.64  |     Q   |V        |         |         |
15+50     160.4433    382.05  |     Q   | V       |         |         |
16+ 0     166.4324    434.81  |      Q  | V       |         |         |
16+10     174.2493    567.51  |         Q  V      |         |         |
16+20     184.9586    777.50  |         |   Q     |         |         |
16+30     198.8214   1006.44  |         |    V  Q |         |         |
16+40     217.4487   1352.34  |         |     V   |   Q     |         |
16+50     243.9335   1922.79  |         |       V |         |   Q     |
17+ 0     273.7134   2162.03  Q100      |         |V        |        Q|
17+10     298.3614   1789.44  |         |         |  V      | Q       |
17+20     318.3103   1448.29  |         |         |   V Q   |         |
17+30     334.4602   1172.49  |         |         |Q   V    |         |
17+40     348.0147    984.06  |         |      Q  |     V   |         |
17+50     359.8053    856.00  |         |    Q    |      V  |         |
18+ 0     370.1252    749.22  |         |  Q      |       V |         |
18+10     379.1683    656.53  |         |Q        |        V|         |
18+20     387.3510    594.07  |         Q         |        V|         |
18+30     394.6133    527.24  |        Q|         |         V         |
18+40     401.3314    487.74  |       Q |         |          V        |
18+50     407.5403    450.76  |       Q |         |         |V        |
19+ 0     413.4847    431.56  |      Q  |         |         |V        |
19+10     419.1475    411.12  |      Q  |         |         | V       |
19+20     424.4335    383.76  |     Q   |         |         | V       |
19+30     429.3908    359.90  |     Q   |         |         |  V      |
19+40     433.9310    329.62  |    Q    |         |         |  V      |
19+50     438.2862    316.19  |    Q    |         |         |  V      |
20+ 0     442.4633    303.25  |    Q    |         |         |   V     |
20+10     446.4211    287.34  |    Q    |         |         |   V     |
20+20     450.2133    275.32  |    Q    |         |         |   V     |
20+30     453.8356    262.98  |   Q     |         |         |    V    |
20+40     457.2699    249.33  |   Q     |         |         |    V    |
20+50     460.4983    234.38  |   Q     |         |         |    V    |
21+ 0     463.6413    228.18  |   Q     |         |         |    V    |
21+10     466.6721    220.03  |   Q     |         |         |     V   |
21+20     469.5132    206.27  |  Q      |         |         |     V   |
21+30     472.2622    199.58  |  Q      |         |         |     V   |
21+40     474.9273    193.49  |  Q      |         |         |     V   |
21+50     477.4339    181.98  |  Q      |         |         |     V   |
22+ 0     479.8129    172.71  |  Q      |         |         |      V  |
22+10     482.1275    168.04  |  Q      |         |         |      V  |
22+20     484.3340    160.20  | Q       |         |         |      V  |
22+30     486.3794    148.49  | Q       |         |         |      V  |
22+40     488.3733    144.76  | Q       |         |         |      V  |
22+50     490.3348    142.41  | Q       |         |         |      V  |
23+ 0     492.2889    141.87  | Q       |         |         |       V |
23+10     494.2186    140.09  | Q       |         |         |       V |
23+20     496.1134    137.56  | Q       |         |         |       V |
23+30     497.9753    135.17  | Q       |         |         |       V |
23+40     499.8035    132.73  | Q       |         |         |       V |
23+50     501.5927    129.90  | Q       |         |         |       V |
24+ 0     503.3158    125.09  | Q       |         |         |       V |
-------------------------------------------------------------------
```

STREAM 5

San Bernardino County Rational Hydrology Program

(Hydrology Manual Date - August 1986)

CIVILCADD/CIVILDESIGN Engineering Software, (c) 1989-2004 Version 7.0
Rational Hydrology Study Date: 04/11/08

ABENGOA SOLAR - HARPER LAKE - JOB NO. 3001
SOUTHERN TRIBUTARY AREA - STREAM 5
NODE 51 - NODE 54
100-YEAR STORM EVENT - AMC II

MERRELL-JOHNSON ENGINEERING, INC.
12138 INDUSTRIAL BOULEVARD, SUITE 240
VICTORVILLE, CA 92395
(760) 241-6146 * FAX (760) 241-0566

********* Hydrology Study Control Information **********

Rational hydrology study storm event year is 100.0
Computed rainfall intensity:
Storm year = 100.00 1 hour rainfall = 1.200 (In.)
Slope used for rainfall intensity curve b = 0.7000
Soil antecedent moisture condition (AMC) = 2

++
Process from Point/Station 51.000 to Point/Station 52.000
**** INITIAL AREA EVALUATION ****

UNDEVELOPED (poor cover) subarea
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2) = 86.00
Pervious ratio(Ap) = 1.0000 Max loss rate(Fm)= 0.265(In/Hr)
Initial subarea data:
Initial area flow distance = 1000.000(Ft.)
Top (of initial area) elevation = 2133.000(Ft.)
Bottom (of initial area) elevation = 2124.000(Ft.)
Difference in elevation = 9.000(Ft.)
Slope = 0.00900 s(%)= 0.90
TC = k(0.525)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration = 21.346 min.
Rainfall intensity = 2.474(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.804
Subarea runoff = 19.879(CFS)
Total initial stream area = 10.000(Ac.)
Pervious area fraction = 1.000
Initial area Fm value = 0.265(In/Hr)

++
Process from Point/Station 52.000 to Point/Station 53.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****

Depth of flow = 0.841(Ft.), Average velocity = 2.810(Ft/s)

```
      ******* Irregular Channel Data ***********
-----------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
      1              0.00              1.00
      2             10.00              0.00
      3             20.00              1.00
Manning's 'N' friction factor =   0.035
-----------------------------------------------------------------
Sub-Channel flow  =     19.879(CFS)
  '     '    flow top width =     16.822(Ft.)
  '     '    velocity=    2.810(Ft/s)
  '     '    area =      7.074(Sq.Ft)
  '     '    Froude number =     0.764

Upstream point elevation =  2124.000(Ft.)
Downstream point elevation =  2100.000(Ft.)
Flow length =  1715.000(Ft.)
Travel time  =   10.17 min.
Time of concentration =   31.52 min.
Depth of flow =   0.841(Ft.)
Average velocity =   2.810(Ft/s)
Total irregular channel flow =    19.879(CFS)
Irregular channel normal depth above invert elev. =   0.841(Ft.)
Average velocity of channel(s) =   2.810(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       52.000 to Point/Station       53.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
UNDEVELOPED (poor cover) subarea
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 86.00
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.265(In/Hr)
Time of concentration =    31.52 min.
Rainfall intensity =      1.883(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.773
Subarea runoff =     97.062(CFS) for   70.300(Ac.)
Total runoff =    116.940(CFS)
Effective area this stream =       80.30(Ac.)
Total Study Area (Main Stream No. 1) =       80.30(Ac.)
Area averaged Fm value =    0.265(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       53.000 to Point/Station       54.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
______________________________________________________________________
Depth of flow =   1.584(Ft.), Average velocity =   5.791(Ft/s)
      ******* Irregular Channel Data ***********
-----------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
      1              0.00              2.00
      2              6.00              0.00
```

```
      3             14.00              0.00
      4             20.00              2.00
Manning's 'N' friction factor =   0.035
----------------------------------------------------------------
Sub-Channel flow  =    116.940(CFS)
  '     '    flow top width =     17.502(Ft.)
  '     '    velocity=    5.791(Ft/s)
  '     '    area =     20.192(Sq.Ft)
  '     '    Froude number =     0.950

Upstream point elevation =  2100.000(Ft.)
Downstream point elevation =  2067.000(Ft.)
Flow length =  2065.000(Ft.)
Travel time  =    5.94 min.
Time of concentration =   37.46 min.
Depth of flow =   1.584(Ft.)
Average velocity =   5.791(Ft/s)
Total irregular channel flow =   116.940(CFS)
Irregular channel normal depth above invert elev. =   1.584(Ft.)
Average velocity of channel(s) =   5.791(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       53.000 to Point/Station       54.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
UNDEVELOPED (poor cover) subarea
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 86.00
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.265(In/Hr)
Time of concentration =    37.46 min. Tc
Rainfall intensity =      1.669(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.757
Subarea runoff =    172.851(CFS) for  149.100(Ac.)
Total runoff =    289.791(CFS) Q100
Effective area this stream =      229.40(Ac.)
Total Study Area (Main Stream No. 1) =      229.40(Ac.)
Area averaged Fm value =    0.265(In/Hr)
End of computations, Total Study Area =          229.40 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.
Note: These figures do not consider reduced effective area
effects caused by confluences in the rational equation.

Area averaged pervious area fraction(Ap) = 1.000
Area averaged SCS curve number =  86.0
```

STREAM 6

U n i t H y d r o g r a p h A n a l y s i s

Copyright (c) CIVILCADD/CIVILDESIGN, 1989 - 2004, Version 7.0

Study date 04/11/08

++

San Bernardino County Synthetic Unit Hydrology Method
Manual date - August 1986

MERRELL-JOHNSON ENGINEERING, INC.
12138 INDUSTRIAL BOULEVARD, SUITE 240
VICTORVILLE, CA 92395
(760) 241-6146 * FAX (760) 241-0566

ABENGOA SOLAR - HARPER LAKE - JOB NO. 3001
SOUTHERN TRIBUTARY AREA - STREAM 6
100-YEAR STORM EVENT - AMC II

Storm Event Year = 100

Antecedent Moisture Condition = 2

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

English Units used in output format

Area averaged rainfall intensity isohyetal data:

Sub-Area (Ac.)	Duration (hours)	Isohyetal (In)
Rainfall data for year 100		
12134.00	1	1.20
Rainfall data for year 100		
12134.00	6	1.80
Rainfall data for year 100		
12134.00	24	3.00

++

******** Area-averaged max loss rate, Fm ********

SCS curve No.(AMCII)	SCS curve NO.(AMC 2)	Area (Ac.)	Area Fraction	Fp(Fig C6) (In/Hr)	Ap (dec.)	Fm (In/Hr)
84.0	84.0	12134.00	1.000	0.301	1.000	0.301

Area-averaged adjusted loss rate Fm (In/Hr) = 0.301

********* Area-Averaged low loss rate fraction, Yb **********

Area (Ac.)	Area Fract	SCS CN (AMC2)	SCS CN (AMC2)	S	Pervious Yield Fr
12134.00	1.000	84.0	84.0	1.90	0.505

Area-averaged catchment yield fraction, Y = 0.505
Area-averaged low loss fraction, Yb = 0.495
++
Watercourse length = 72811.00(Ft.)
Length from concentration point to centroid = 37330.00(Ft.)
Elevation difference along watercourse = 834.00(Ft.)
Mannings friction factor along watercourse = 0.030
Watershed area = 12134.00(Ac.)
Catchment Lag time = 1.882 hours
Unit interval = 15.000 minutes
Unit interval percentage of lag time = 13.2830
Hydrograph baseflow = 0.00(CFS)
Average maximum watershed loss rate(Fm) = 0.301(In/Hr)
Average low loss rate fraction (Yb) = 0.495 (decimal)
DESERT S-Graph Selected
Computed peak 5-minute rainfall = 0.569(In)
Computed peak 30-minute rainfall = 0.975(In)
Specified peak 1-hour rainfall = 1.200(In)
Computed peak 3-hour rainfall = 1.539(In)
Specified peak 6-hour rainfall = 1.800(In)
Specified peak 24-hour rainfall = 3.000(In)

Rainfall depth area reduction factors:
Using a total area of 12134.00(Ac.) (Ref: fig. E-4)

5-minute factor = 0.633 Adjusted rainfall = 0.360(In)
30-minute factor = 0.651 Adjusted rainfall = 0.634(In)
1-hour factor = 0.655 Adjusted rainfall = 0.786(In)
3-hour factor = 0.934 Adjusted rainfall = 1.436(In)
6-hour factor = 0.968 Adjusted rainfall = 1.742(In)
24-hour factor = 0.981 Adjusted rainfall = 2.943(In)

U n i t H y d r o g r a p h
++

Interval Number	'S' Graph Mean values	Unit Hydrograph ((CFS))
	(K = 48915.19 (CFS))	
1	0.586	286.789
2	2.355	865.020
3	5.254	1418.074
4	9.433	2044.332
5	16.977	3689.955
6	29.170	5964.589
7	40.762	5670.281
8	49.581	4313.729
9	56.457	3363.143
10	61.590	2511.098
11	65.681	2001.043
12	69.147	1695.575

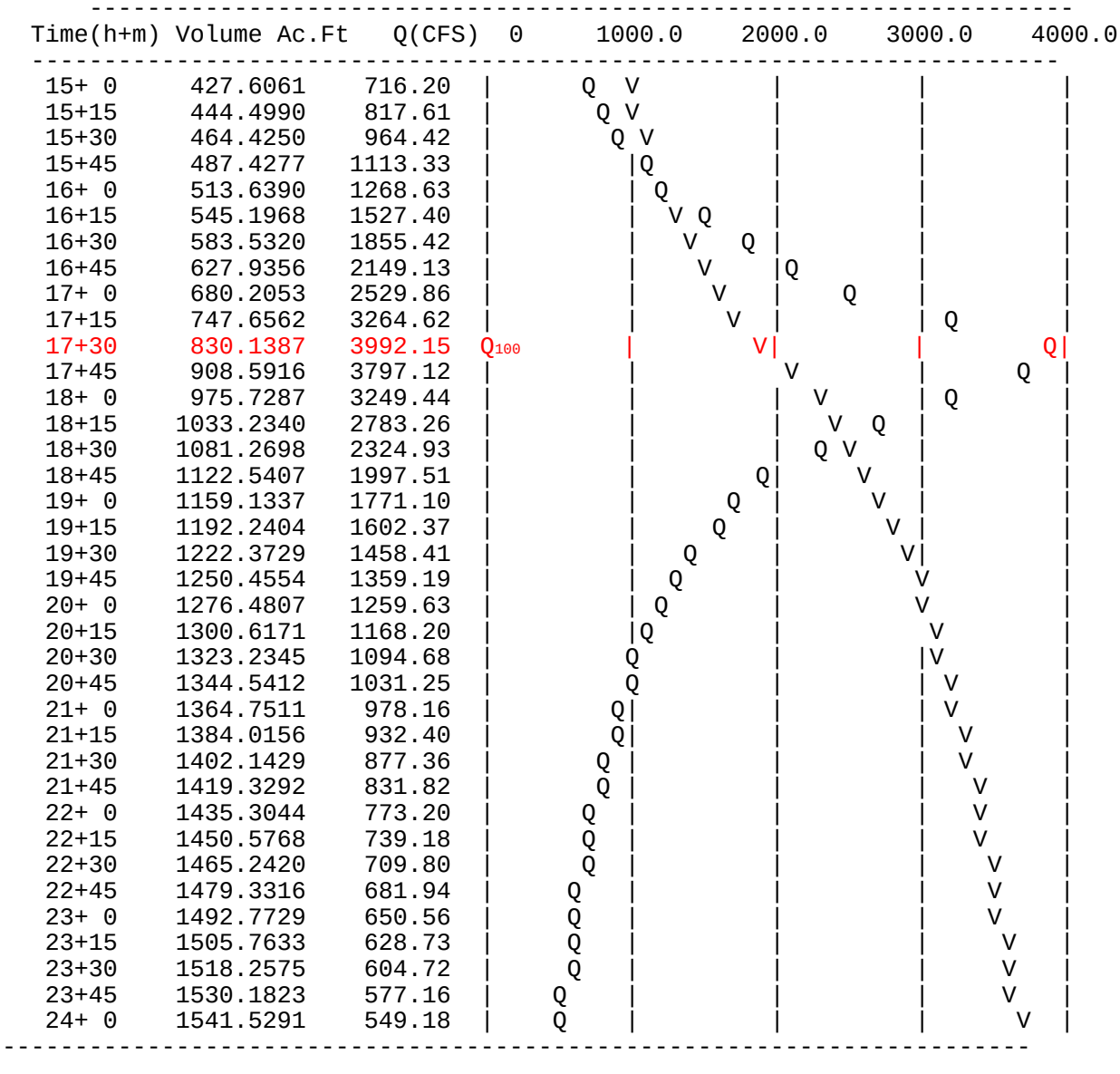
13	72.193	1489.740
14	74.756	1253.473
15	77.057	1125.604
16	79.076	987.872
17	80.830	857.745
18	82.405	770.455
19	83.837	700.472
20	85.166	650.030
21	86.432	619.171
22	87.547	545.490
23	88.587	508.615
24	89.429	412.097
25	90.219	386.158
26	90.968	366.693
27	91.690	352.855
28	92.334	315.049
29	92.955	304.202
30	93.541	286.583
31	94.074	260.362
32	94.526	221.332
33	94.978	220.912
34	95.429	220.524
35	95.815	188.960
36	96.160	168.933
37	96.506	168.933
38	96.844	165.602
39	97.105	127.667
40	97.344	116.953
41	97.583	116.953
42	97.804	107.791
43	97.945	69.263
44	98.078	64.974
45	98.211	64.974
46	98.353	69.446
47	98.512	77.780
48	98.671	77.969
49	98.831	77.969
50	98.990	77.969
51	99.150	77.969
52	99.309	77.969
53	99.465	76.275
54	99.567	49.732
55	99.650	40.609
56	99.733	40.609
57	99.816	40.609
58	99.899	40.609
59	100.000	20.304

Total soil rain loss = 1.29(In)
Total effective rainfall = 1.65(In)
Peak flow rate in flood hydrograph = 3992.15(CFS)

++
24 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 15 Minute intervals ((CFS))

Time(h+m)	Volume Ac.Ft	Q(CFS)
15+ 0	427.6061	716.20
15+15	444.4990	817.61
15+30	464.4250	964.42
15+45	487.4277	1113.33
16+ 0	513.6390	1268.63
16+15	545.1968	1527.40
16+30	583.5320	1855.42
16+45	627.9356	2149.13
17+ 0	680.2053	2529.86
17+15	747.6562	3264.62
17+30	830.1387	3992.15
17+45	908.5916	3797.12
18+ 0	975.7287	3249.44
18+15	1033.2340	2783.26
18+30	1081.2698	2324.93
18+45	1122.5407	1997.51
19+ 0	1159.1337	1771.10
19+15	1192.2404	1602.37
19+30	1222.3729	1458.41
19+45	1250.4554	1359.19
20+ 0	1276.4807	1259.63
20+15	1300.6171	1168.20
20+30	1323.2345	1094.68
20+45	1344.5412	1031.25
21+ 0	1364.7511	978.16
21+15	1384.0156	932.40
21+30	1402.1429	877.36
21+45	1419.3292	831.82
22+ 0	1435.3044	773.20
22+15	1450.5768	739.18
22+30	1465.2420	709.80
22+45	1479.3316	681.94
23+ 0	1492.7729	650.56
23+15	1505.7633	628.73
23+30	1518.2575	604.72
23+45	1530.1823	577.16
24+ 0	1541.5291	549.18



STREAM 7

```
            San Bernardino County Rational Hydrology Program

                (Hydrology Manual Date - August 1986)

 CIVILCADD/CIVILDESIGN  Engineering Software, (c) 1989-2004 Version 7.0
      Rational Hydrology Study        Date: 04/11/08
----------------------------------------------------------------------
ABENGOA SOLAR - HARPER LAKE - JOB NO. 3001
SOUTHERN TRIBUTARY AREA - STREAM 7
NODE 71 - NODE 73
100-YEAR STORM EVENT - AMC II
----------------------------------------------------------------------
MERRELL-JOHNSON ENGINEERING, INC.
12138 INDUSTRIAL BOULEVARD, SUITE 240
VICTORVILLE, CA 92395
(760) 241-6146 * FAX (760) 241-0566
----------------------------------------------------------------------
 *********   Hydrology Study Control Information **********

----------------------------------------------------------------------
Rational hydrology study storm event year is   100.0
Computed rainfall intensity:
Storm year =   100.00   1 hour rainfall =     1.200 (In.)
Slope used for rainfall intensity curve b =  0.7000
Soil antecedent moisture condition (AMC) = 2


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       71.000 to Point/Station       72.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
UNDEVELOPED (poor cover) subarea
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 86.00
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.265(In/Hr)
Initial subarea data:
Initial area flow distance =  1000.000(Ft.)
Top (of initial area) elevation =  2100.000(Ft.)
Bottom (of initial area) elevation =  2092.000(Ft.)
Difference in elevation =     8.000(Ft.)
Slope =    0.00800  s(%)=       0.80
TC = k(0.525)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =   21.855 min.
Rainfall intensity =      2.433(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.802
Subarea runoff =      8.782(CFS)
Total initial stream area =        4.500(Ac.)
Pervious area fraction = 1.000
Initial area Fm value =    0.265(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       72.000 to Point/Station       73.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
______________________________________________________________________
Depth of flow =   0.653(Ft.), Average velocity =   2.059(Ft/s)
      ******* Irregular Channel Data ***********
```

```
----------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
      1              0.00              1.00
      2             10.00              0.00
      3             20.00              1.00
Manning's 'N' friction factor =   0.035
----------------------------------------------------------------
Sub-Channel flow  =      8.782(CFS)
  '     '    flow top width =     13.061(Ft.)
  '     '    velocity=    2.059(Ft/s)
  '     '    area =      4.265(Sq.Ft)
  '     '    Froude number =     0.635

Upstream point elevation =  2092.000(Ft.)
Downstream point elevation =  2060.000(Ft.)
Flow length =  3039.000(Ft.)
Travel time  =   24.60 min.
Time of concentration =   46.45 min.
Depth of flow =   0.653(Ft.)
Average velocity =   2.059(Ft/s)
Total irregular channel flow =     8.782(CFS)
Irregular channel normal depth above invert elev. =   0.653(Ft.)
Average velocity of channel(s) =   2.059(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       72.000 to Point/Station       73.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
UNDEVELOPED (poor cover) subarea
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 86.00
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.265(In/Hr)
Time of concentration =    46.45 min. Tc
Rainfall intensity =      1.435(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.734
Subarea runoff =     48.201(CFS) for   49.600(Ac.)
Total runoff =     56.983(CFS) Q100
Effective area this stream =       54.10(Ac.)
Total Study Area (Main Stream No. 1) =       54.10(Ac.)
Area averaged Fm value =    0.265(In/Hr)
End of computations, Total Study Area =           54.10 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.
Note: These figures do not consider reduced effective area
effects caused by confluences in the rational equation.

Area averaged pervious area fraction(Ap) = 1.000
Area averaged SCS curve number =  86.0
```

STREAM 10

```
            San Bernardino County Rational Hydrology Program

                (Hydrology Manual Date - August 1986)

 CIVILCADD/CIVILDESIGN  Engineering Software, (c) 1989-2004 Version 7.0
      Rational Hydrology Study        Date: 11/18/08
----------------------------------------------------------------------
ABENGOA SOLAR - HARPER LAKE - JOB NO. 3001
NORTHWEST TRIBUTARY AREA - STREAM 10
NODE 11 - NODE 15
100-YEAR STORM EVENT - AMC II
----------------------------------------------------------------------
MERRELL-JOHNSON ENGINEERING, INC.
12138 INDUSTRIAL BOULEVARD, SUITE 240
VICTORVILLE, CA 92395
(760) 241-6146 * FAX (760) 241-0566
----------------------------------------------------------------------
 *********   Hydrology Study Control Information **********

----------------------------------------------------------------------
Rational hydrology study storm event year is   100.0
Computed rainfall intensity:
Storm year =   100.00   1 hour rainfall =     1.200 (In.)
Slope used for rainfall intensity curve b =  0.7000
Soil antecedent moisture condition (AMC) = 2


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       11.000 to Point/Station       12.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
UNDEVELOPED (poor cover) subarea
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 86.00
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.265(In/Hr)
Initial subarea data:
Initial area flow distance =   986.000(Ft.)
Top (of initial area) elevation =  2202.000(Ft.)
Bottom (of initial area) elevation =  2177.000(Ft.)
Difference in elevation =    25.000(Ft.)
Slope =    0.02535  s(%)=       2.54
TC = k(0.525)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =   17.254 min.
Rainfall intensity =      2.871(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.817
Subarea runoff =     23.455(CFS)
Total initial stream area =       10.000(Ac.)
Pervious area fraction = 1.000
Initial area Fm value =    0.265(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       12.000 to Point/Station       13.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
______________________________________________________________________
Depth of flow =   0.814(Ft.), Average velocity =   3.176(Ft/s)
```

```
      ******* Irregular Channel Data ***********
-----------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
      1              0.00              1.00
      2              5.00              0.00
      3             10.00              0.00
      4             15.00              1.00
Manning's 'N' friction factor =   0.035
-----------------------------------------------------------------
Sub-Channel flow  =     23.455(CFS)
  '     '    flow top width =     13.141(Ft.)
  '     '    velocity=    3.176(Ft/s)
  '     '    area =      7.384(Sq.Ft)
  '     '    Froude number =     0.747

Upstream point elevation =  2177.000(Ft.)
Downstream point elevation =  2150.000(Ft.)
Flow length =  2201.000(Ft.)
Travel time  =   11.55 min.
Time of concentration =   28.80 min.
Depth of flow =   0.814(Ft.)
Average velocity =   3.176(Ft/s)
Total irregular channel flow =    23.455(CFS)
Irregular channel normal depth above invert elev. =   0.814(Ft.)
Average velocity of channel(s) =   3.176(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       12.000 to Point/Station       13.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
UNDEVELOPED (poor cover) subarea
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 86.00
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.265(In/Hr)
Time of concentration =    28.80 min.
Rainfall intensity =      2.006(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.781
Subarea runoff =     55.188(CFS) for   40.200(Ac.)
Total runoff =     78.642(CFS)
Effective area this stream =       50.20(Ac.)
Total Study Area (Main Stream No. 1) =       50.20(Ac.)
Area averaged Fm value =    0.265(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       13.000 to Point/Station       14.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
______________________________________________________________________
Depth of flow =   1.270(Ft.), Average velocity =   3.787(Ft/s)
      ******* Irregular Channel Data ***********
-----------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
      1              0.00              2.00
```

```
      2             10.00              0.00
      3             20.00              0.00
      4             30.00              2.00
Manning's 'N' friction factor =   0.035
----------------------------------------------------------------
Sub-Channel flow  =     78.642(CFS)
  '     '    flow top width =     22.700(Ft.)
  '     '    velocity=    3.787(Ft/s)
  '     '    area =     20.765(Sq.Ft)
  '     '    Froude number =     0.698

Upstream point elevation =  2150.000(Ft.)
Downstream point elevation =  2120.000(Ft.)
Flow length =  3299.000(Ft.)
Travel time  =   14.52 min.
Time of concentration =   43.32 min.
Depth of flow =   1.270(Ft.)
Average velocity =   3.787(Ft/s)
Total irregular channel flow =    78.642(CFS)
Irregular channel normal depth above invert elev. =   1.270(Ft.)
Average velocity of channel(s) =   3.787(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       13.000 to Point/Station       14.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
UNDEVELOPED (poor cover) subarea
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 86.00
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.265(In/Hr)
Time of concentration =    43.32 min.
Rainfall intensity =      1.507(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.742
Subarea runoff =    174.242(CFS) for  176.000(Ac.)
Total runoff =    252.885(CFS)
Effective area this stream =      226.20(Ac.)
Total Study Area (Main Stream No. 1) =      226.20(Ac.)
Area averaged Fm value =    0.265(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       14.000 to Point/Station       15.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
______________________________________________________________________
Depth of flow =   1.490(Ft.), Average velocity =   4.531(Ft/s)
      ******* Irregular Channel Data ***********
----------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
      1              0.00              4.00
      2             20.00              0.00
      3             50.00              0.00
      4             70.00              4.00
Manning's 'N' friction factor =   0.035
----------------------------------------------------------------
```

```
Sub-Channel flow  =    252.885(CFS)
  '     '    flow top width =     44.902(Ft.)
  '     '    velocity=    4.531(Ft/s)
  '     '    area =     55.811(Sq.Ft)
  '     '    Froude number =     0.716

Upstream point elevation =  2120.000(Ft.)
Downstream point elevation =  2085.000(Ft.)
Flow length =  4071.000(Ft.)
Travel time  =   14.97 min.
Time of concentration =   58.30 min.
Depth of flow =   1.490(Ft.)
Average velocity =   4.531(Ft/s)
Total irregular channel flow =   252.885(CFS)
Irregular channel normal depth above invert elev. =   1.490(Ft.)
Average velocity of channel(s) =   4.531(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       14.000 to Point/Station       15.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
UNDEVELOPED (poor cover) subarea
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 86.00
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.265(In/Hr)
Time of concentration =    58.30 min. Tc
Rainfall intensity =      1.224(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.705
Subarea runoff =    204.728(CFS) for  303.800(Ac.)
Total runoff =    457.612(CFS) Q100
Effective area this stream =      530.00(Ac.)
Total Study Area (Main Stream No. 1) =      530.00(Ac.)
Area averaged Fm value =    0.265(In/Hr)
End of computations, Total Study Area =          530.00 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.
Note: These figures do not consider reduced effective area
effects caused by confluences in the rational equation.

Area averaged pervious area fraction(Ap) = 1.000
Area averaged SCS curve number =  86.0
```

EXHIBITS

SOILS MAP

PROJECT SITE

SOURCE: 1970 SCS SURVEY

SOURCE: 1970 SCS SURVEY

SOURCE: 1970 SCS SURVEY

SOURCE: GEOLOGY MAP

SOURCE: GEOLOGY MAP

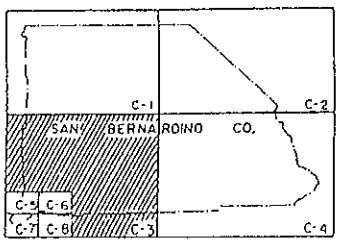
SOURCE: 1970 SCS SURVEY

SOURCE: 1970 SCS SURVEY

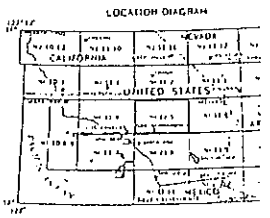
SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

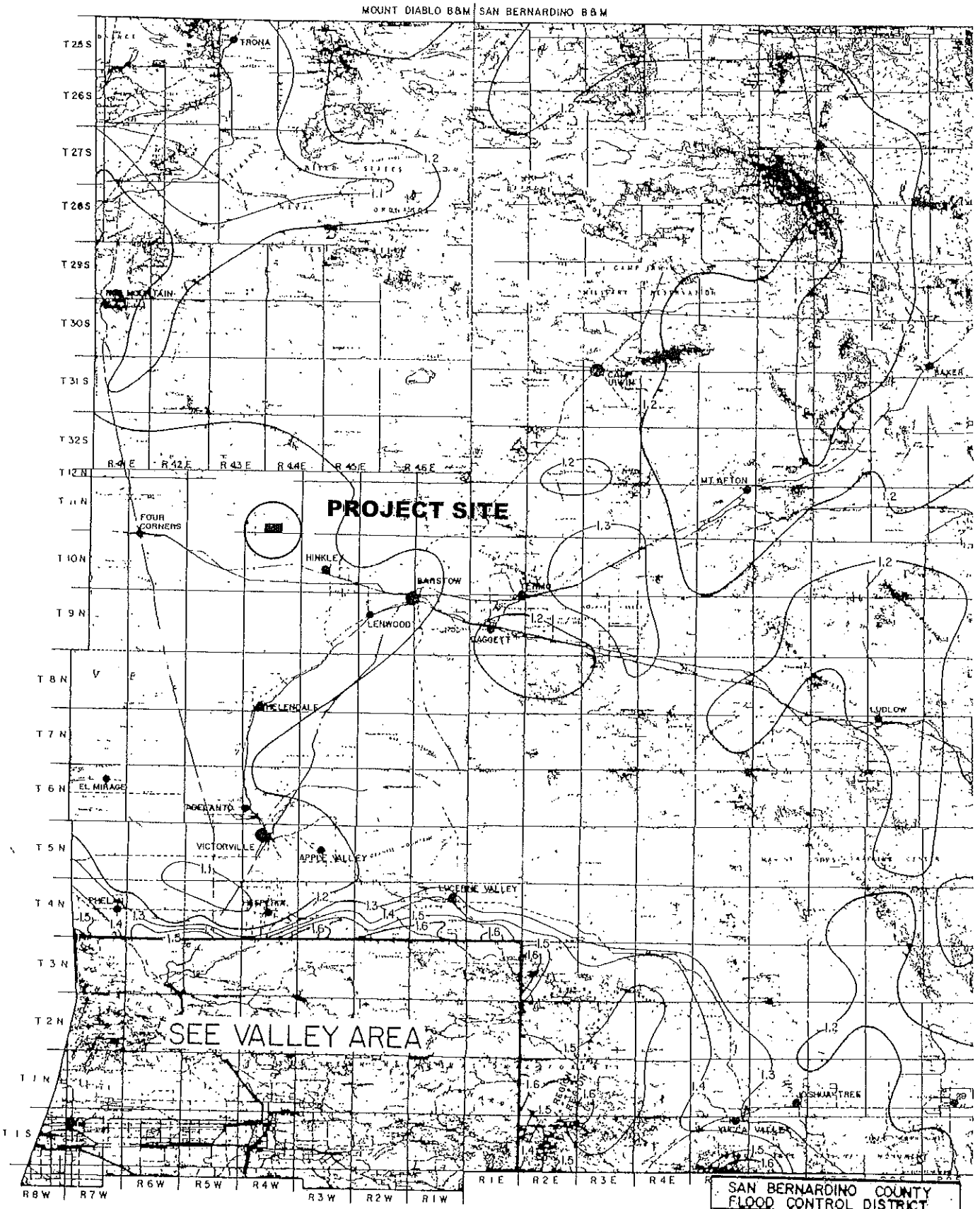
HYDROLOGIC SOILS GROUP MAP FOR SOUTHCENTRAL AREA



INDEX MAP



ISOHYETAL MAP



SAN BERNARDINO COUNTY
FLOOD CONTROL DISTRICT

DESERT AREA
ISOHYETALS
Y_{100} - 100 YEAR 1 HOUR
BASED ON U.S.D.C., N.O.A.A. ATLAS 2, 1973

APPROVED BY
FLOOD CONTROL ENGINEER

DATE	SCALE	FILE NO.	DRWG. NO.

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

UNIT HYDROGRAPH DATA SHEETS

PROJECT: ABENGOA SOLAR STREAM 2 DATE: 12 APRIL 2008

ENGINEER: MARK ROWAN

1. Enter the design storm return frequency **(years)** 100
2. Enter catchment lag **(hours)** 24
3. Enter the catchment area **(acres)** 1,133
4. Enter baseflow **(cfs/square mile)** Ø
5. Enter S-Graph proportions **(decimal)**

Valley: Developed	
Foothill	
Mountain	
Valley: Undeveloped	
Desert	1.0

6. Enter maximum loss rate, F_m **(inch/hour)** AMC II 0.31
7. Enter low loss fraction, $\bar{Y}$ **(decimal)** 0.49
8. Enter watershed area-averaged 5-minute point rainfall **(inches)*** 0.58

   Enter watershed area-averaged 30-minute point rainfall **(inches)*** 0.98

   Enter watershed area-averaged 1-hour point rainfall **(inches)*** 1.2

   Enter watershed area-averaged 3-hour point rainfall **(inches)*** 1.6

   Enter watershed area-averaged 6-hour point rainfall **(inches)*** 1.8

   Enter watershed area-averaged 24-hour point rainfall **(inches)*** 3.0
9. Enter 24-hour storm unit interval **(minutes)** 5

*Note: enter values unadjusted by depth-area factors

SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

WATERSHED INFORMATION FORM

Figure E-7

PROJECT: ABENGOA SOLAR STREAM 4 DATE: 12 APRIL 2008

ENGINEER: MARK ROWAN

1. Enter the design storm return frequency **(years)** 100

2. Enter catchment lag **(hours)** 24

3. Enter the catchment area **(acres)** 3,520

4. Enter baseflow **(cfs/square mile)** Ø

5. Enter S-Graph proportions **(decimal)**

Valley: Developed	
Foothill	
Mountain	
Valley: Undeveloped	
Desert	1.0

6. Enter maximum loss rate, F_m **(inch/hour)** AMC II 0.31

7. Enter low loss fraction, $\bar{Y}$ **(decimal)** 0.49

8. Enter watershed area-averaged 5-minute point rainfall **(inches)*** 0.58

   Enter watershed area-averaged 30-minute point rainfall **(inches)*** 0.98

   Enter watershed area-averaged 1-hour point rainfall **(inches)*** 1.2

   Enter watershed area-averaged 3-hour point rainfall **(inches)*** 1.6

   Enter watershed area-averaged 6-hour point rainfall **(inches)*** 1.8

   Enter watershed area-averaged 24-hour point rainfall **(inches)*** 3.0

9. Enter 24-hour storm unit interval **(minutes)** 15

*Note: enter values unadjusted by depth-area factors

SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

WATERSHED INFORMATION FORM

Figure E-7

PROJECT: ABENGOA SOLAR STREAM 6 DATE: 12 APRIL 2008

ENGINEER: MARK ROWAN

1.	Enter the design storm return frequency **(years)**	100
2.	Enter catchment lag **(hours)**	24
3.	Enter the catchment area **(acres)**	12,134
4.	Enter baseflow **(cfs/square mile)**	Ø
5.	Enter S-Graph proportions **(decimal)**	
	Valley: Developed	
	Foothill	
	Mountain	
	Valley: Undeveloped	
	Desert	1.0
6.	Enter maximum loss rate, F_m **(inch/hour)** AMC II	0.31
7.	Enter low loss fraction, $\bar{Y}$ **(decimal)**	0.49
8.	Enter watershed area-averaged 5-minute point rainfall **(inches)***	0.58
	Enter watershed area-averaged 30-minute point rainfall **(inches)***	0.98
	Enter watershed area-averaged 1-hour point rainfall **(inches)***	1.2
	Enter watershed area-averaged 3-hour point rainfall **(inches)***	1.6
	Enter watershed area-averaged 6-hour point rainfall **(inches)***	1.8
	Enter watershed area-averaged 24-hour point rainfall **(inches)***	3.0
9.	Enter 24-hour storm unit interval **(minutes)**	15

*Note: enter values unadjusted by depth-area factors

SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

WATERSHED INFORMATION FORM

Figure E-7

Curve (1) Numbers of Hydrologic Soil-Cover Complexes For Pervious Areas-AMC II

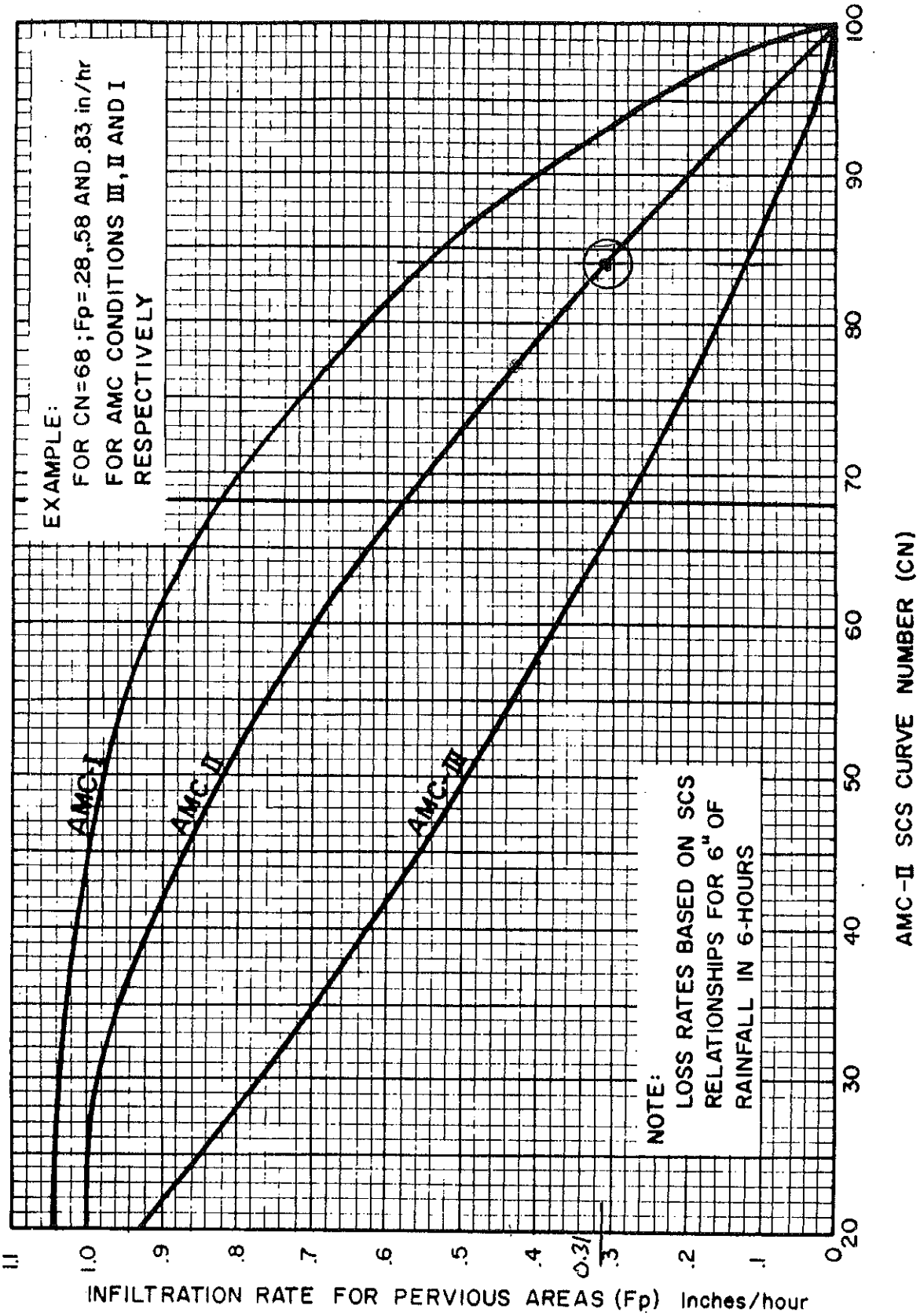
Cover Type (3)	Quality of Cover (2)	Soil Group A	B	C	D
NATURAL COVERS -					
Barren (Rockland, eroded and graded land)		78	86	91	93
Chaparral, Broadleaf (Manzonita, ceanothus and scrub oak)	Poor	53	70	80	85
	Fair	40	63	75	81
	Good	31	57	71	78
Chaparral, Narrowleaf (Chamise and redshank)	Poor	71	82	88	91
	Fair	55	72	81	86
Grass, Annual or Perennial	Poor	67	78	86	89
	Fair	50	69	79	84
	Good	38	61	74	80
Meadows or Cienegas (Areas with seasonally high water table, principal vegetation is sod forming grass)	Poor	63	77	85	88
	Fair	51	70	80	84
	Good	30	58	71	78
Open Brush (Soft wood shrubs - buckwheat, sage, etc.)	Poor	62	76	84	88
	Fair	46	66	77	83
	Good	41	63	75	81
Woodland (Coniferous or broadleaf trees predominate. Canopy density is at least 50 percent.)	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	25	55	70	77
Woodland, Grass (Coniferous or broadleaf trees with canopy density from 20 to 50 percent)	Poor	57	73	82	86
	Fair	44	65	77	82
	Good	33	58	72	79
URBAN COVERS -					
Residential or Commercial Landscaping (Lawn, shrubs, etc.)	Good	32	56	69	75
Turf (Irrigated and mowed grass)	Poor	58	74	83	87
	Fair	44	65	77	82
	Good	33	58	72	79
AGRICULTURAL COVERS -					
Fallow (Land plowed but not tilled or seeded)		77	86	91	94

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

CURVE NUMBERS FOR PERVIOUS AREAS

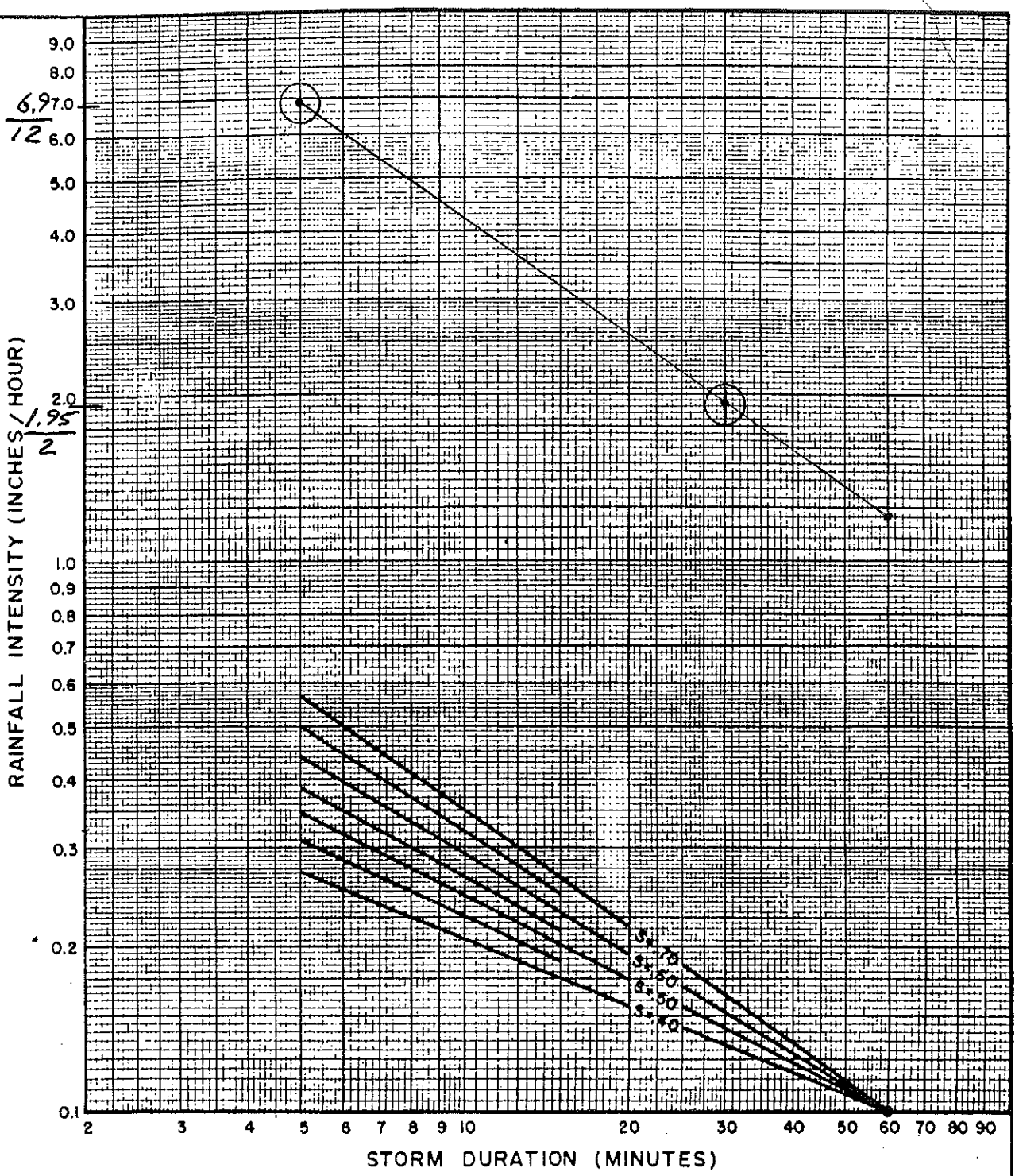
Figure C-3 (1 of 2)



SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

INFILTRATION RATE FOR PERVIOUS AREAS VERSUS SCS CURVE NUMBERS

Figure C-6



DESIGN STORM FREQUENCY = 100 YEARS

ONE HOUR POINT RAINFALL = 1.2 INCHES

LOG-LOG SLOPE = 0.7

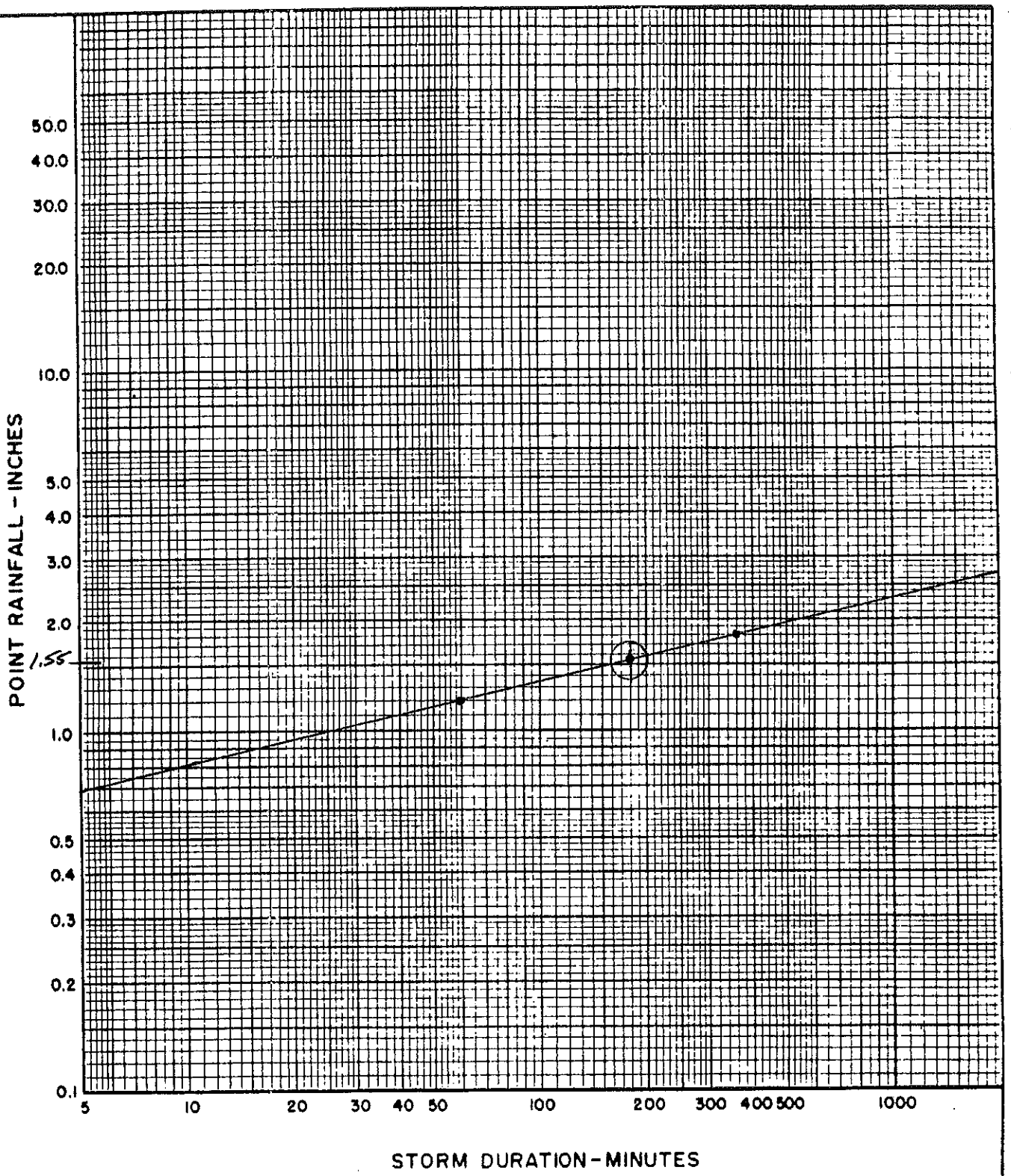
PROJECT LOCATION = DESERT - HARPER LAKE

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET

FIGURE D-3



PROJECT LOCATION HARPER LAKE

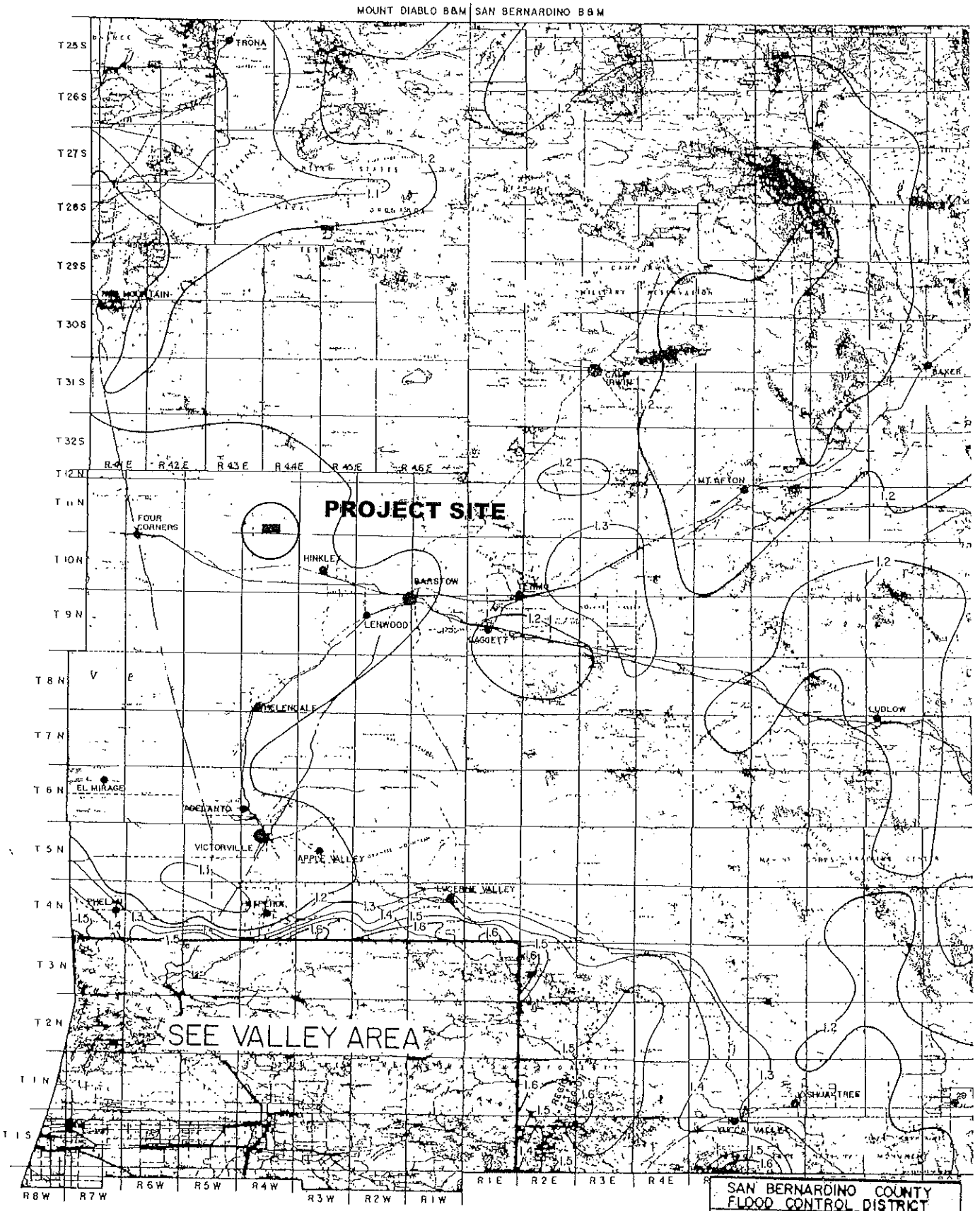
NOTES STREAMS 2, 4, AND 6

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

AREA - AVERAGED MASS RAINFALL PLOTTING SHEET

FIGURE E-8



SAN BERNARDINO COUNTY
FLOOD CONTROL DISTRICT

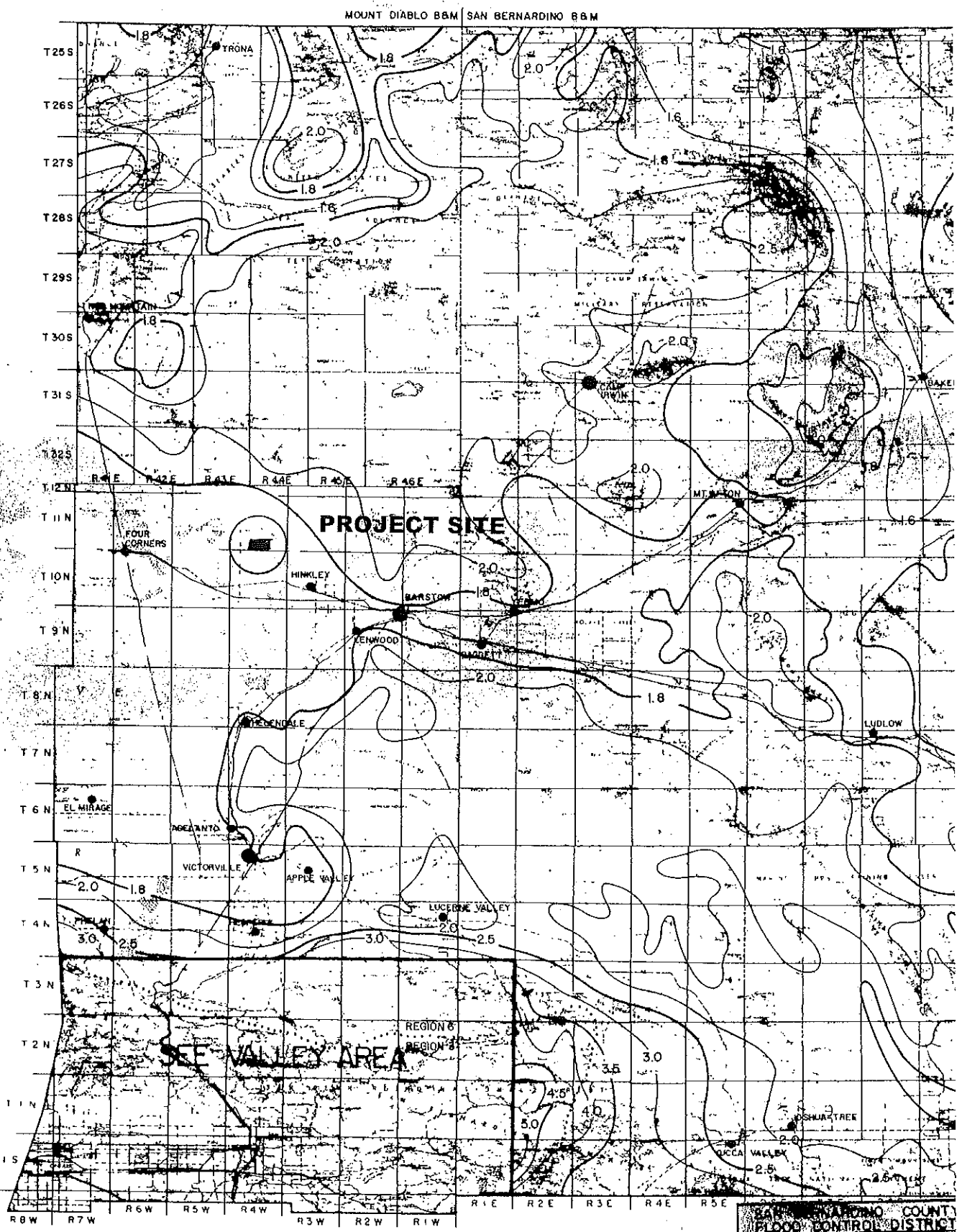
DESERT AREA
ISOHYETALS
Y_{100}-100 YEAR 1 HOUR
BASED ON U.S.D.C., N.O.A.A. ATLAS 2, 1973

APPROVED BY
FLOOD CONTROL ENGINEER

DATE	SCALE	FILE NO.	DRWG. NO.

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL



SAN BERNARDINO COUNTY FLOOD CONTROL DISTRICT

DESERT AREA

ISOHYETAL S

X_1 - 100 YEAR 6 HOUR

BASED ON USGS, NOAA, ATLAS 2, WT

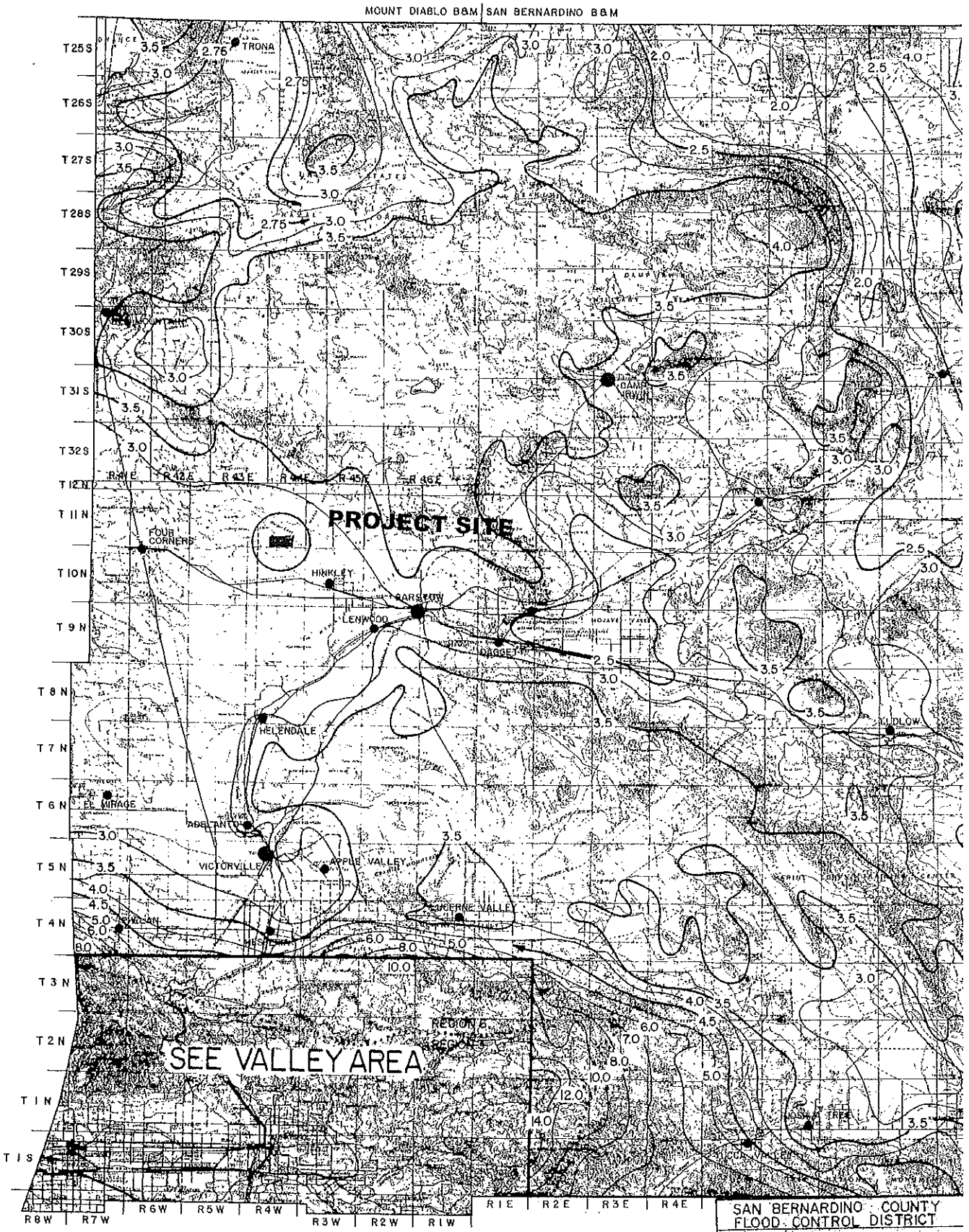
APPROVED BY: B. A. Wright

FLOOD CONTROL ENGINEER

DATE	SCALE	FILE NO.	DRAWING
1982	1" = 6 MI.	WRD-1	11

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL



SAN BERNARDINO COUNTY
FLOOD CONTROL DISTRICT

DESERT AREA

ISOHYETALS

X_4 -100 YEAR 24 HOUR

BASED ON U.S.D.C., N.O.A.A. ATLAS-2, 1973

APPROVED BY

FLOOD CONTROL ENGINEER

DATE	SCALE	FILE NO.	DRWG. NO.
1982	1" = 6 MI.	WRD-1	12 of 12

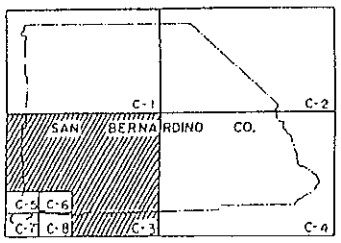
SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

SAN BERNARDINO COUNTY

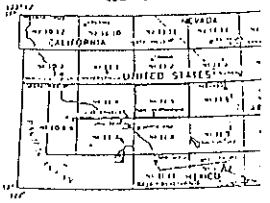
HYDROLOGY MANUAL

HYDROLOGIC SOILS GROUP MAP
FOR
SOUTHCENTRAL AREA



INDEX MAP

LOCATION DIAGRAM



$\bar{n}$ = 0.015

1. Drainage area has fairly uniform, gentle slopes
2. Most watercourses either improved or along paved streets
3. Groundcover consists of some grasses - large % of area impervious
4. Main water course improved channel or conduit

$\bar{n}$ = 0.020

1. Drainage area has some graded and non-uniform, gentle slopes
2. Over half of the area watercourses are improved or paved streets
3. Groundcover consists of equal amount of grasses and impervious area
4. Main watercourse is partly improved channel or conduit and partly greenbelt (see n = 0.025)

$\bar{n}$ = 0.025

1. Drainage area is generally rolling with gentle side slopes
2. Some drainage improvements in the area - streets and canals
3. Groundcover consists mostly of scattered brush and grass and small % impervious
4. Main watercourse is straight channels which are turfed or with stony beds and weeds on earth bank (greenbelt type)

$\bar{n}$ = 0.030

1. Drainage area is generally rolling with rounded ridges and moderate side slopes
2. No drainage improvements exist in the area
3. Groundcover includes scattered brush and grasses
4. Watercourses meander in fairly straight, unimproved channels with some boulders and lodged debris

$\bar{n}$ = 0.040

1. Drainage area is composed of steep upper canyons with moderate slopes in lower canyons
2. No drainage improvements exist in the area
3. Groundcover is mixed brush and trees with grasses in lower canyons
4. Watercourses have moderate bends and are moderately impeded by boulders and debris with meandering courses

$\bar{n}$ = 0.050

1. Drainage area is quite rugged with sharp ridges and steep canyons
2. No drainage improvements exist in the area
3. Groundcover, excluding small areas of rock outcrops, includes many trees and considerable underbrush
4. Watercourses meander around sharp bends, over large boulders and considerable debris obstruction

$\bar{n}$ = 0.200

1. Drainage area has comparatively uniform slopes
2. No drainage improvements exist in the area
3. Groundcover consists of cultivated crops or substantial growths of grass and fairly dense small shrubs, cacti, or similar vegetation
4. Surface characteristics are such that channelization does not occur

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

BASIN FACTOR DESCRIPTIONS

Merrell–Johnson Engineering, Inc.
12138 Industrial Boulevard, Suite 240
Victorville, CA 92392
(760) 241–6146 Fax:(760) 241–0566

Date: Page of

Project Name:
Job No:

CALCULATION OF LOW LOSS FRACTION, $\bar{Y}$

$S = (1000/CN) - 10$ CN = 84 OPEN BRUSH "POOR COVER"

$= (1000/84) - 10$

$= 11.90 - 10$

$S = 1.90$

$$Y = \frac{(P_{24} - 0.2S)^2}{(P_{24} + 0.8S)P_{24}}$$

$$= \frac{(3.0 - 0.2(1.9))^2}{(3.0 + 0.8(1.9))3.0}$$

$$= \frac{(2.62)^2}{(4.52)3.0}$$

$$= \frac{6.8644}{13.56}$$

$Y = 0.51$

$\bar{Y} = 1 - Y$

$= 1 - 0.51$

$\bar{Y} = 0.49$

SECTION 4

STORM DRAIN CAPACITY CALCULATIONS

Merrell-Johnson Engineering, Inc.
CIVIL ENGINEERING ♦ SURVEYING

CHANNEL CALCULATIONS

ABENGOA SOLAR
Q100 FLOW = 14,788 CUBIC FEET PER SECOND
CHANNEL A1 @ 0.7%

d	5.98		
M	2.00		
m	3		
b	180		
A	1166.22081		
Rn	5.35372596		
n	0.03	Dirt Lined Channel	
S	0.007	Minimum Channel Slope	
V	12.6828639		
Q	14791.0198		
desired Q	14788	Q 100	Standard Flood Flow
delta	3.01983951		

5.98	d	Flow depth
2 ; 3	m	Side slope (run) as in rise over run w/ rise =1
180	b	base width
	A	Cross sectional area
0.03	n	manning coef.
0.70%	S	Channel Slope

Right-of-Way Calculations

Flow Depth =	5.98	FT
Velocity =	12.68	FtPS
Bulk Depth =	8.97	FT
Free Board =	3	FT
Total Depth =	11.97	FT
Dike Width =	18	FT
Bottom Width =	180	FT

R/W=2[5' + 2(Freeboard) + Dike] + 2(d Total) + 3(d Total) + Bottom Width

R/W = 298 FT

ABENGOA SOLAR
Q100 FLOW = 14,788 CUBIC FEET PER SECOND
CHANNEL A2 @ 0.4%

d	5.96		
M	2.00		
m	3		
b	240		
A	1520.013		
Rn	5.473318		
n	0.03	Dirt Lined Channel	
S	0.004	Minimum Channel Slope	
V	9.729593		
Q	14789.11		
desired Q	14788	Q 100	Standard Flood Flow
delta	1.112466		

5.96	d	Flow depth
2 ; 3	m	Side slope (run) as in rise over run w/ rise =1
240	b	base width
	A	Cross sectional area
0.03	n	manning coef.
0.40%	S	Channel Slope

Right-of-Way Calculations

Flow Depth =	5.96	FT
Velocity =	9.73	FtPS
Bulk Depth =	8.94	FT
Free Board =	3	FT
Total Depth =	11.94	FT
Dike Width =	18	FT
Bottom Width =	240	FT

R/W=2[5' + 2(Freeboard) + Dike] + 2(d Total) + 3(d Total) + Bottom Width

R/W = 358 FT

ABENGOA SOLAR
Q100 FLOW = 21,232 CUBIC FEET PER SECOND
CHANNEL A3 @ 0.7%

d	5.97		
M	2.00		
m	3		
b	260		
A	1641.882		
Rn	5.513922		
n	0.03	Dirt Lined Channel	
S	0.007	Minimum Channel Slope	
V	12.93462		
Q	21237.12		
desired Q	21232	Q 100	Standard Flood Flow
delta	5.118728		

5.97	d	Flow depth
2 ; 3	m	Side slope (run) as in rise over run w/ rise =1
260	b	base width
	A	Cross sectional area
0.03	n	manning coef.
0.70%	S	Channel Slope

Right-of-Way Calculations

Flow Depth =	5.97	FT
Velocity =	12.93	FtPS
Bulk Depth =	8.96	FT
Free Board =	3	FT
Total Depth =	11.96	FT
Dike Width =	18	FT
Bottom Width =	260	FT

R/W=2[5' + 2(Freeboard) + Dike] + 2(d Total) + 3(d Total) + Bottom Width

R/W = 378 FT

ABENGOA SOLAR
Q100 FLOW = 4,282 CUBIC FEET PER SECOND
CHANNEL B

d	4.56		
M	2.00		
m	3		
b	90		
A	462.7224		
Rn	3.893038		
n	0.03	Dirt Lined Channel	
S	0.0057	Minimum Channel Slope	
V	9.254666		
Q	4282.342		
desired Q	4282	Q 100	Standard Flood Flow
delta	0.3416		

4.56	d	Flow depth
2 ; 3	m	Side slope (run) as in rise over run w/ rise =1
90	b	base width
	A	Cross sectional area
0.03	n	manning coef.
0.57%	S	Channel Slope

Right-of-Way Calculations

Flow Depth =	4.56	FT
Velocity =	9.25	FtPS
Bulk Depth =	6.84	FT
Free Board =	3	FT
Total Depth =	9.84	FT
Dike Width =	18	FT
Bottom Width =	90	FT

R/W=2[5' + 2(Freeboard) + Dike] + 2(d Total) + 3(d Total) + Bottom Width

R/W = 197 FT

ABENGOA SOLAR
Q100 FLOW = 2,162 CUBIC FEET PER SECOND
CHANNEL C

d	4.20		
M	2.00		
m	3		
b	55		
A	274.7201		
Rn	3.369496		
n	0.03	Dirt Lined Channel	
S	0.005	Minimum Channel Slope	
V	7.872134		
Q	2162.633		
desired Q	2162	Q 100	Standard Flood Flow
delta	0.633182		

4.2	d	Flow depth
2 ; 3	m	Side slope (run) as in rise over run w/ rise =1
55	b	base width
	A	Cross sectional area
0.03	n	manning coef.
0.50%	S	Channel Slope

Right-of-Way Calculations

Flow Depth =	4.20	FT
Velocity =	7.87	FtPS
Bulk Depth =	6.29	FT
Free Board =	2	FT
Total Depth =	8.29	FT
Dike Width =	18	FT
Bottom Width =	55	FT

R/W=2[5' + 2(Freeboard) + Dike] + 2(d Total) + 3(d Total) + Bottom Width

R/W = 150 FT

ABENGOA SOLAR
Q100 FLOW = 6,444 CUBIC FEET PER SECOND
CHANNEL D

d	4.97		
M	2.00		
m	3		
b	90		
A	508.4781		
Rn	4.188403		
n	0.03	Dirt Lined Channel	
S	0.0097	Minimum Channel Slope	
V	12.676		
Q	6445.47		
desired Q	6444	Q 100	Standard Flood Flow
delta	1.470406		

4.97	d	Flow depth
2 ; 3	m	Side slope (run) as in rise over run w/ rise =1
90	b	base width
	A	Cross sectional area
0.03	n	manning coef.
0.97%	S	Channel Slope

Right-of-Way Calculations

Flow Depth =	4.97	FT
Velocity =	12.68	FtPS
Bulk Depth =	7.45	FT
Free Board =	3	FT
Total Depth =	10.45	FT
Dike Width =	18	FT
Bottom Width =	90	FT

R/W=2[5' + 2(Freeboard) + Dike] + 2(d Total) + 3(d Total) + Bottom Width

R/W = 200 FT

ABENGOA SOLAR
Q100 FLOW = 1,477 CUBIC FEET PER SECOND
CHANNEL E

d	4.06		
M	2.00		
m	3.00		
b	65		
A	304.8531		
Rn	3.362645		
n	0.03	Dirt Lined Channel	
S	0.0019	Minimum Channel Slope	
V	4.84613		
Q	1477.358		
desired Q	1477	Q 100	Standard Flood Flow
delta	0.357869		

4.06	d	Flow depth
2 ; 3	m	Side slope (run) as in rise over run w/ rise =1
100	b	base width
	A	Cross sectional area
0.03	n	manning coef.
0.19%	S	Channel Slope

Right-of-Way Calculations

Flow Depth =	4.06	FT
Velocity =	4.85	FtPS
Bulk Depth =	4.06	FT
Free Board =	2	FT
Total Depth =	6.06	FT
Dike Width =	18	FT
Bottom Width =	65	FT

R/W=2[5' + 2(Freeboard) + Dike] + 2(d Total) + 3(d Total) + Bottom Width

R/W = 149 FT

ABENGOA SOLAR
Q100 FLOW = 458 CUBIC FEET PER SECOND
CHANNEL F

d	2.74		
M	2.00		
m	2.00		
b	20		
A	69.8152		
Rn	2.164567		
n	0.03	Dirt Lined Channel	
S	0.0063	Minimum Channel Slope	
V	6.578828		
Q	459.3022		
desired Q	458	Q 100	Standard Flood Flow
delta	1.302213		

2.74	d	Flow depth
2 ; 2	m	Side slope (run) as in rise over run w/ rise =1
20	b	base width
	A	Cross sectional area
0.03	n	manning coef.
0.63%	S	Channel Slope

Right-of-Way Calculations

Flow Depth =	2.74	FT
Velocity =	6.58	FtPS
Bulk Depth =	4.11	FT
Free Board =	2	FT
Total Depth =	6.11	FT
Dike Width =	15	FT
Bottom Width =	20	FT

R/W=2[5' + 2(Freeboard) + Dike] + 2(d Total) + 3(d Total) + Bottom Width

R/W = 92 FT

ROADWAY CROSSING CALCULATIONS

ALL-WEATHER CROSSING – HARPER LAKE ROAD

Merrell-Johnson Engineering, Inc.
CIVIL ENGINEERING ♦ SURVEYING

HY-8 Culvert Analysis Report

Table 1 - Summary of Culvert Flows at Crossing: Harper Lake Road

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2053.18	0.00	0.00	0.00	1
2055.76	2218.20	2218.20	0.00	1
2057.25	4436.40	4436.40	0.00	1
2058.46	6654.60	6654.60	0.00	1
2059.48	8872.80	8872.80	0.00	1
2060.51	11091.00	11091.00	0.00	1
2061.51	13309.20	13309.20	0.00	1
2062.17	14788.00	14788.00	0.00	1
2063.49	17745.60	17745.60	0.00	1
2064.89	19963.80	19963.80	0.00	1
2066.31	22182.00	22058.90	121.71	5

Rating Curve Plot for Crossing: Harper Lake Road

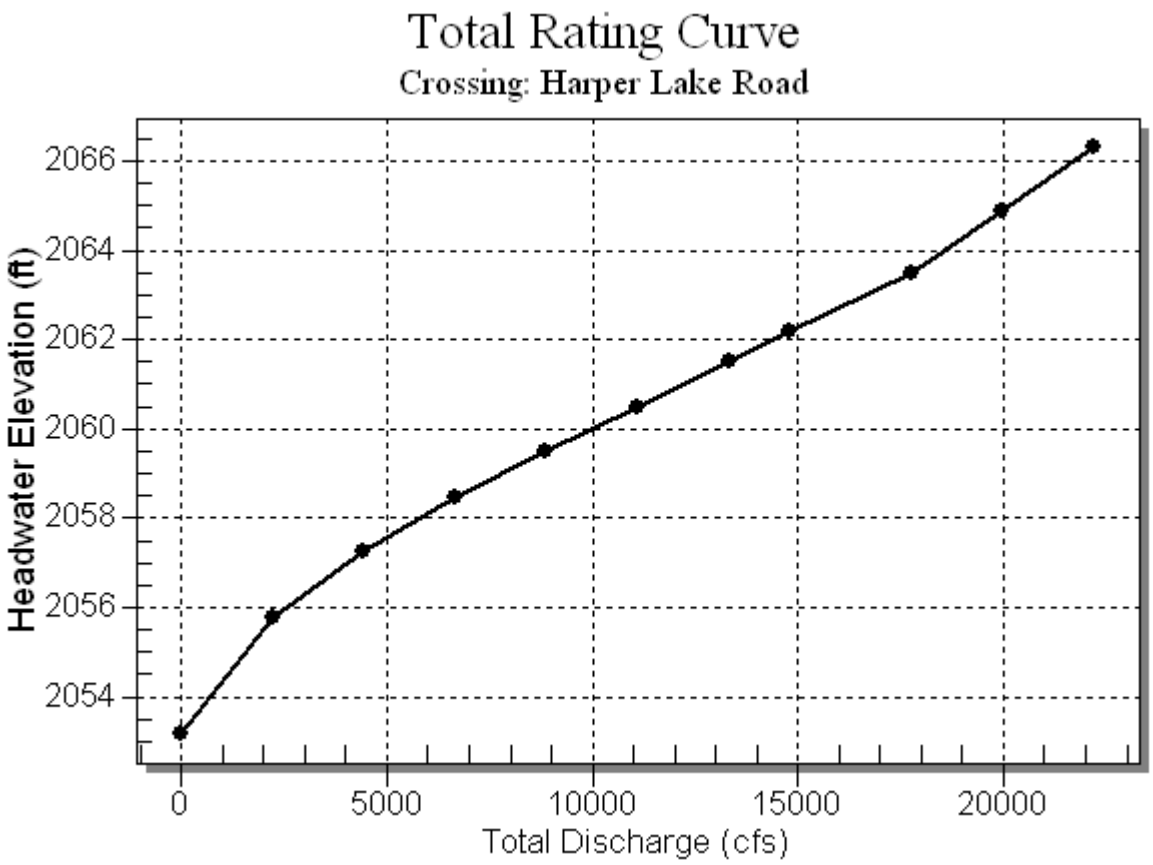


Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	2053.18	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
2218.20	2218.20	2055.76	2.579	2.579	1-S2n	0.975	1.403	1.112	1.615	8.865	5.646
4436.40	4436.40	2057.25	4.066	4.066	1-S2n	1.463	2.273	1.823	2.447	10.820	7.403
6654.60	6654.60	2058.46	5.275	5.275	1-S2n	1.937	3.006	2.441	3.118	12.126	8.667
8872.80	8872.80	2059.48	6.300	6.300	1-S2n	2.310	3.615	2.997	3.704	13.173	9.683
11091.00	11091.00	2060.51	7.325	7.325	1-S2n	2.667	4.195	3.515	4.232	14.052	10.549
13309.20	13309.20	2061.51	8.331	8.331	1-S2n	3.020	4.726	3.986	4.718	14.879	11.309
14788.00	14788.00	2062.17	8.990	8.990	1-S2n	3.223	5.072	4.307	5.025	15.338	11.770
17745.60	17745.60	2063.49	10.308	10.308	5-S2n	3.629	5.703	4.892	5.602	16.266	12.611
19963.80	19963.80	2064.89	11.709	11.709	5-S2n	3.934	6.155	5.321	6.008	16.892	13.184
22182.00	22058.90	2066.31	13.126	13.126	5-S2n	4.206	6.551	5.694	6.398	17.508	13.715

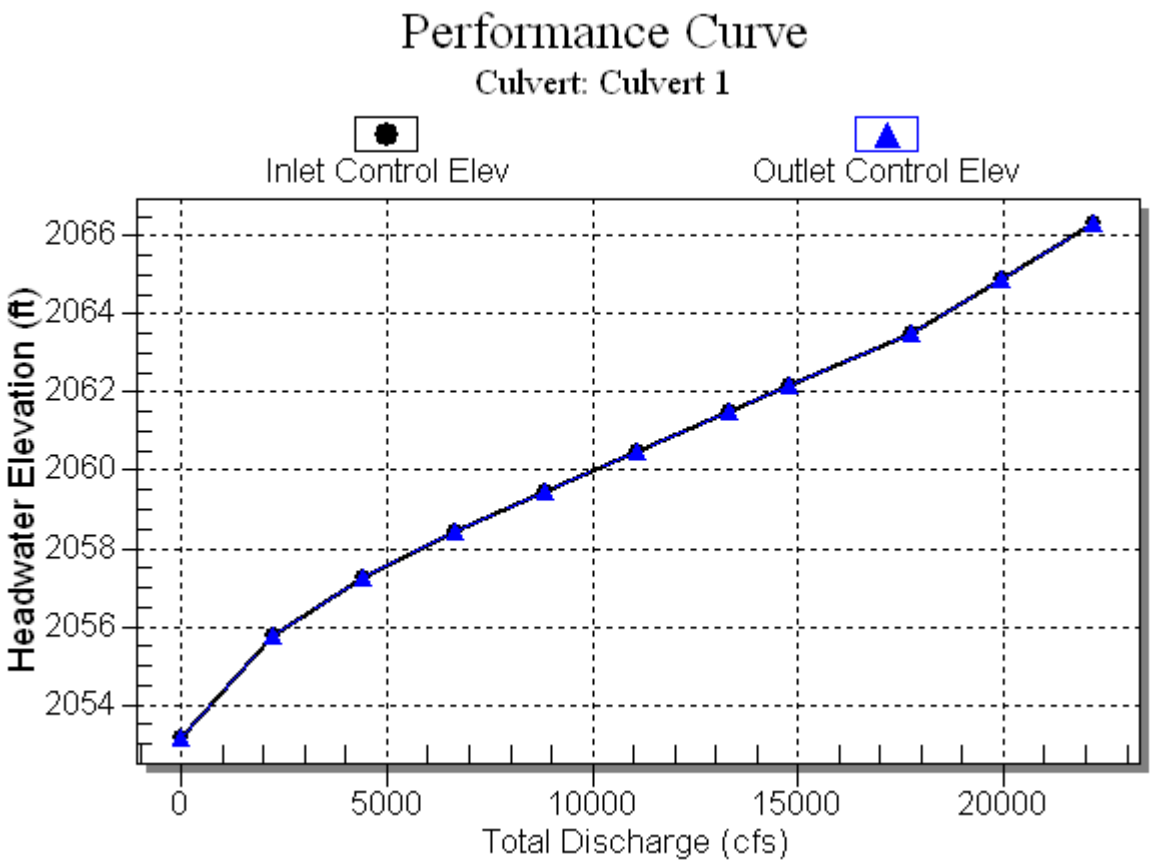
****

Inlet Elevation (invert): 2053.18 ft, Outlet Elevation (invert): 2052.82 ft

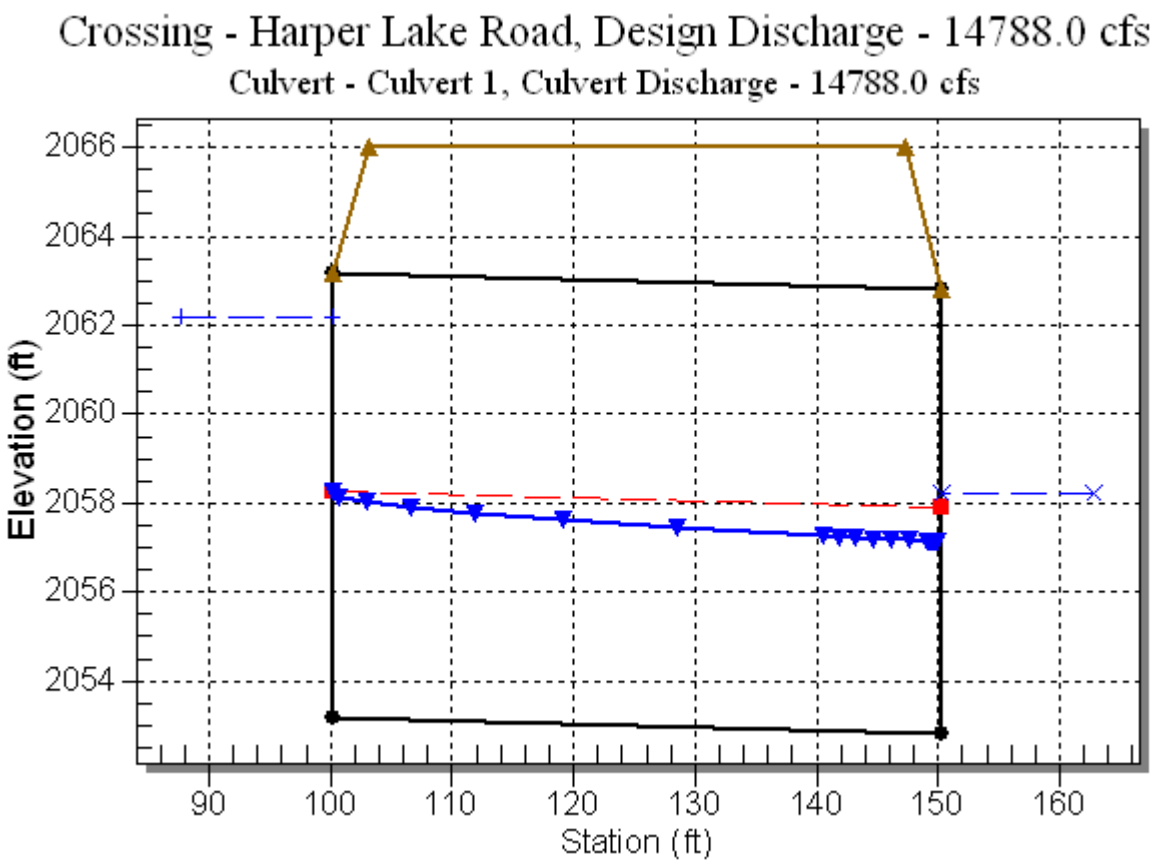
Culvert Length: 50.00 ft, Culvert Slope: 0.0072

****

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 100.00 ft

Inlet Elevation: 2053.18 ft

Outlet Station: 150.00 ft

Outlet Elevation: 2052.82 ft

Number of Barrels: 7

Culvert Data Summary - Culvert 1

Barrel Shape: Arch-Box, Concrete

Barrel Span: 32.00 ft

Barrel Rise: 10.00 ft

Barrel Material: Concrete

Barrel Manning's n: 0.0120 (top and sides)

Manning's n: 1.4lf (bottom)

Inlet Type: Conventional

Inlet Edge Condition: Mitered to Conform to Slope

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: Harper Lake Road)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	2053.18	0.00	0.00	0.00	0.00
2218.20	2054.80	1.62	5.65	0.71	0.79
4436.40	2055.63	2.45	7.40	1.07	0.84
6654.60	2056.30	3.12	8.67	1.36	0.88
8872.80	2056.88	3.70	9.68	1.62	0.90
11091.00	2057.41	4.23	10.55	1.85	0.92
13309.20	2057.90	4.72	11.31	2.06	0.93
14788.00	2058.20	5.02	11.77	2.19	0.94
17745.60	2058.78	5.60	12.61	2.45	0.96
19963.80	2059.19	6.01	13.18	2.62	0.97
22182.00	2059.58	6.40	13.71	2.79	0.98

Tailwater Channel Data - Harper Lake Road

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 240.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0070

Channel Manning's n: 0.0300

Channel Invert Elevation: 2053.18 ft

Roadway Data for Crossing: Harper Lake Road

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 240.00 ft

Crest Elevation: 2066.00 ft

Roadway Surface: Paved

Roadway Top Width: 44.00 ft

ALL-WEATHER CROSSING – LOCKHART ROAD

Merrell-Johnson Engineering, Inc.
CIVIL ENGINEERING ♦ SURVEYING

HY-8 Culvert Analysis Report

Table 1 - Summary of Culvert Flows at Crossing: Lockhart Road

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2035.25	0.00	0.00	0.00	1
2038.03	966.60	966.60	0.00	1
2039.65	1933.20	1933.20	0.00	1
2040.91	2899.80	2899.80	0.00	1
2042.06	3866.40	3866.40	0.00	1
2043.21	4833.00	4833.00	0.00	1
2044.32	5799.60	5799.60	0.00	1
2045.06	6444.00	6444.00	0.00	1
2046.95	7732.80	7732.80	0.00	1
2048.64	8699.40	8699.40	0.00	1
2050.38	9666.00	9666.00	0.00	1

Rating Curve Plot for Crossing: Lockhart Road

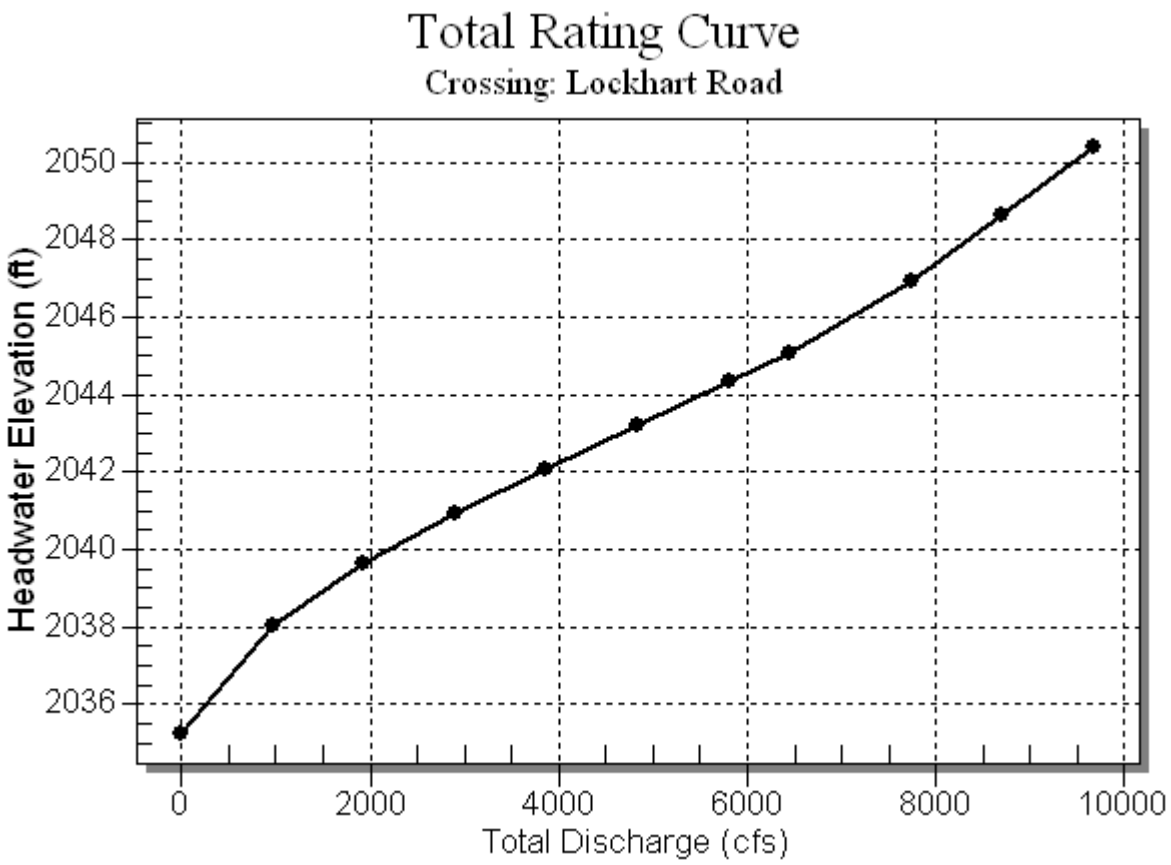


Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	2035.25	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
966.60	966.60	2038.03	2.783	2.783	1-S2n	0.963	1.553	1.157	1.599	9.866	6.486
1933.20	1933.20	2039.65	4.399	4.399	1-S2n	1.454	2.504	1.921	2.416	11.885	8.436
2899.80	2899.80	2040.91	5.657	5.657	1-S2n	1.927	3.299	2.587	3.075	13.244	9.809
3866.40	3866.40	2042.06	6.809	6.809	1-S2n	2.302	4.015	3.194	3.648	14.310	10.895
4833.00	4833.00	2043.21	7.956	7.956	1-S2n	2.659	4.625	3.752	4.162	15.233	11.811
5799.60	5799.60	2044.32	9.067	9.067	1-S2n	3.014	5.211	4.276	4.634	16.053	12.608
6444.00	6444.00	2045.06	9.808	9.808	1-S2n	3.217	5.578	4.607	4.931	16.574	13.088
7732.80	7732.80	2046.95	11.699	11.699	5-S2n	3.621	6.271	5.237	5.488	17.547	13.955
8699.40	8699.40	2048.64	13.386	13.386	5-S2n	3.924	6.751	5.691	5.880	18.230	14.539
9666.00	9666.00	2050.38	15.131	15.131	5-S2n	4.209	7.208	6.118	6.253	18.913	15.080

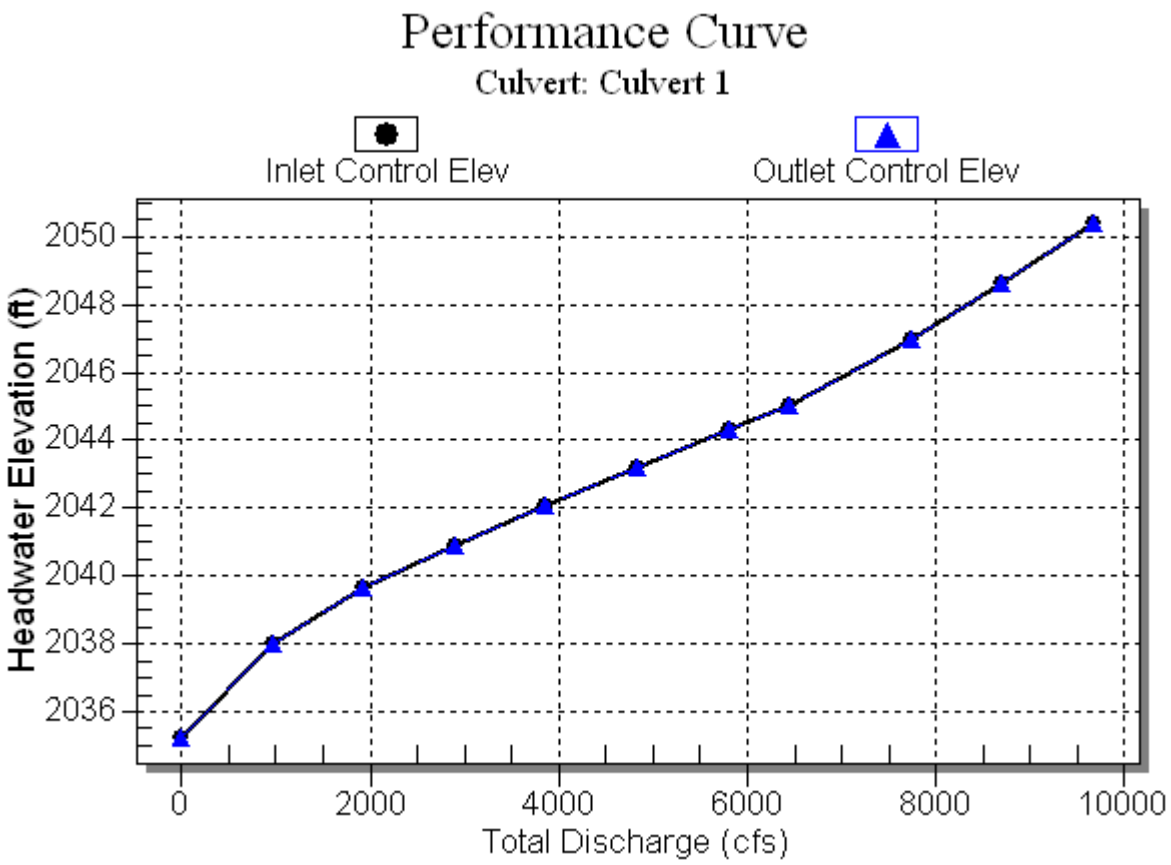
****

Inlet Elevation (invert): 2035.25 ft, Outlet Elevation (invert): 2034.75 ft

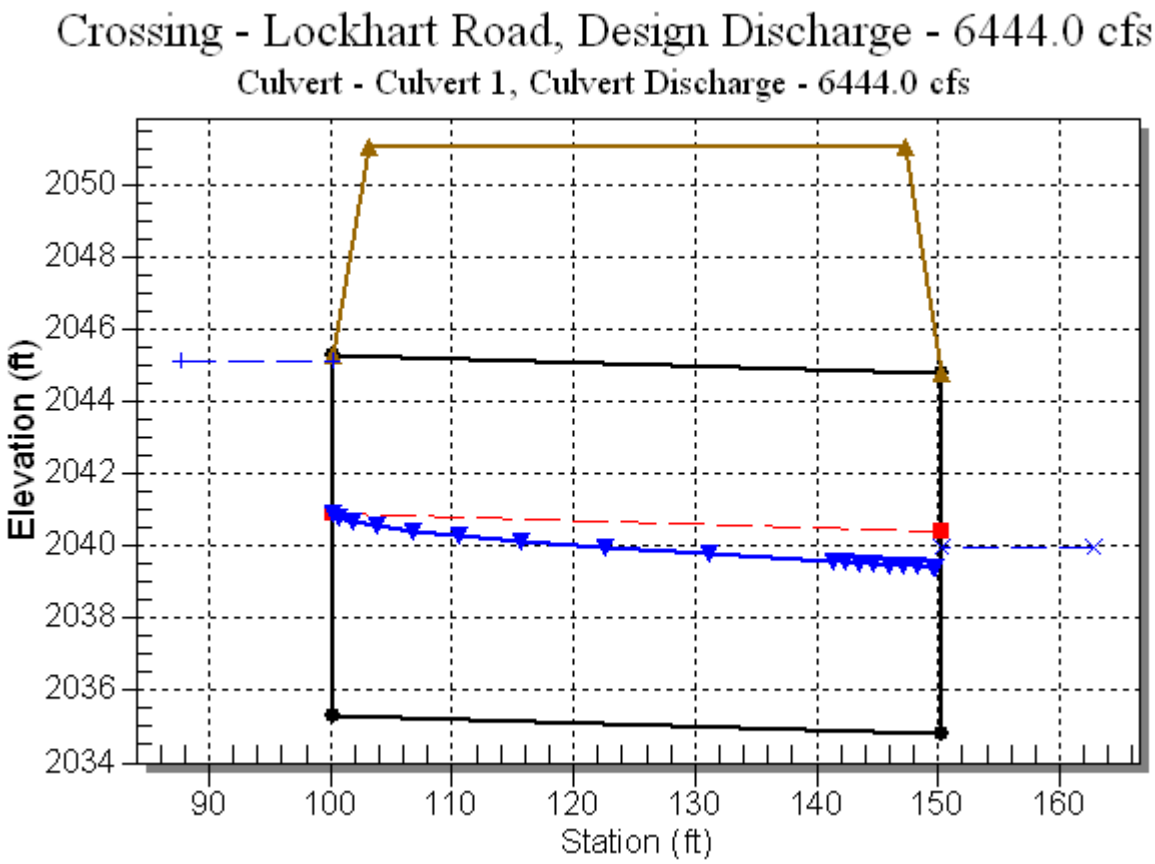
Culvert Length: 50.00 ft, Culvert Slope: 0.0100

****

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 100.00 ft

Inlet Elevation: 2035.25 ft

Outlet Station: 150.00 ft

Outlet Elevation: 2034.75 ft

Number of Barrels: 3

Culvert Data Summary - Culvert 1

Barrel Shape: Arch-Box, Concrete

Barrel Span: 28.00 ft

Barrel Rise: 10.00 ft

Barrel Material: Concrete

Barrel Manning's n: 0.0120 (top and sides)

Manning's n: 1.4lf (bottom)

Inlet Type: Conventional

Inlet Edge Condition: Mitered to Conform to Slope

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: Lockhart Road)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	2035.00	0.00	0.00	0.00	0.00
966.60	2036.60	1.60	6.49	0.97	0.92
1933.20	2037.42	2.42	8.44	1.46	0.98
2899.80	2038.07	3.07	9.81	1.86	1.02
3866.40	2038.65	3.65	10.89	2.21	1.04
4833.00	2039.16	4.16	11.81	2.52	1.06
5799.60	2039.63	4.63	12.61	2.80	1.08
6444.00	2039.93	4.93	13.09	2.98	1.09
7732.80	2040.49	5.49	13.96	3.32	1.11
8699.40	2040.88	5.88	14.54	3.56	1.12
9666.00	2041.25	6.25	15.08	3.78	1.13

Tailwater Channel Data - Lockhart Road

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 90.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0097

Channel Manning's n: 0.0300

Channel Invert Elevation: 2035.00 ft

Roadway Data for Crossing: Lockhart Road

Roadway Profile Shape: Constant Roadway Elevation

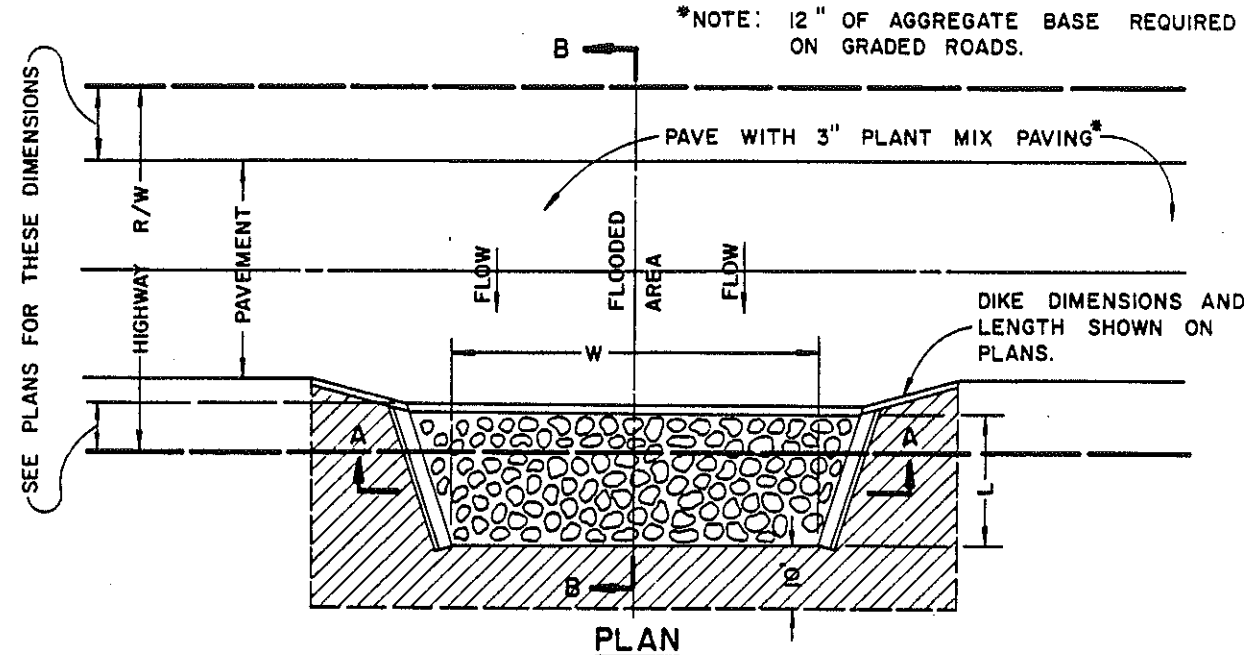
Crest Length: 90.00 ft

Crest Elevation: 2051.00 ft

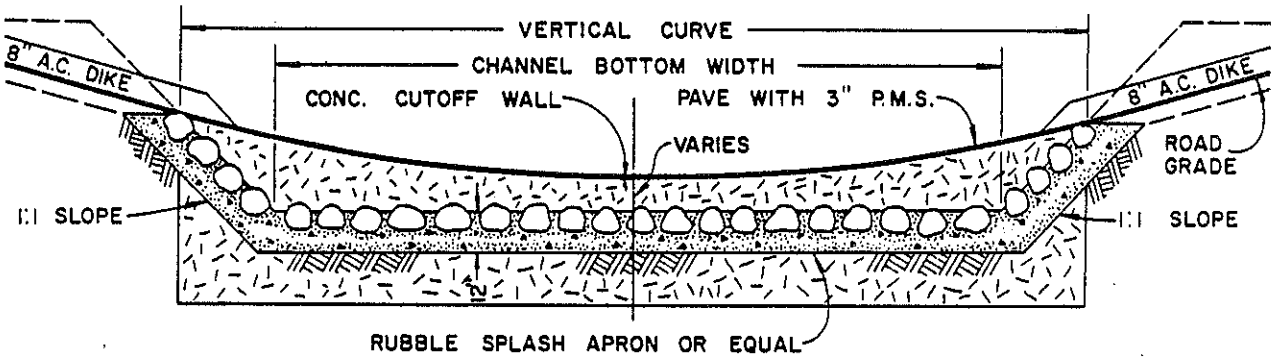
Roadway Surface: Paved

Roadway Top Width: 44.00 ft

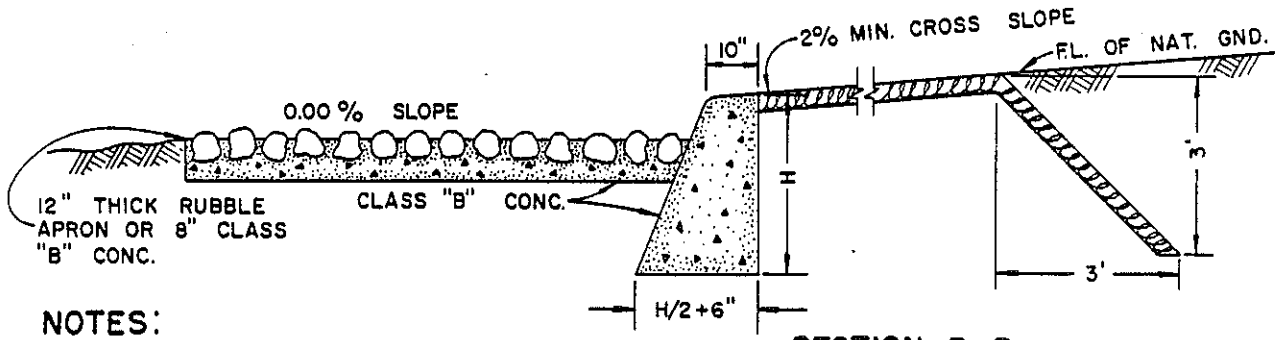
CHANNEL BOTTOM CROSSING DETAILS



PLAN



SECTION A-A

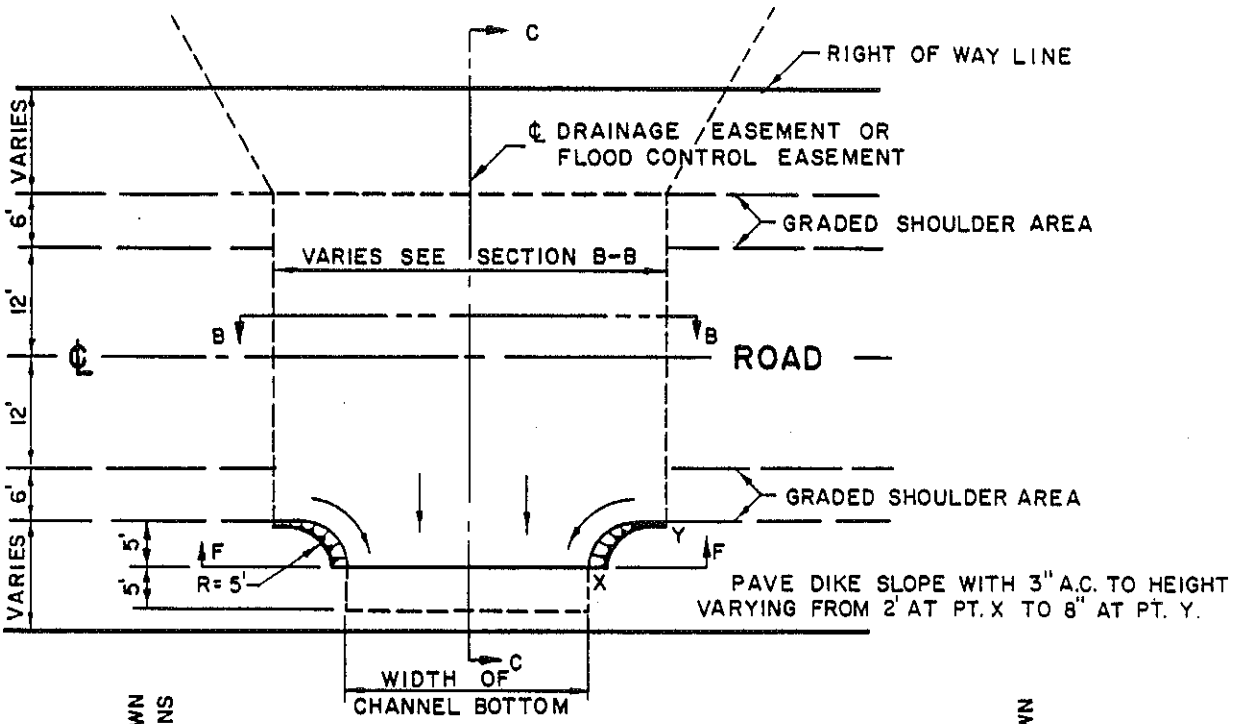


SECTION B-B

NOTES:

1. ALL CONCRETE TO BE CLASS "B".
2. L = SHOWN ON PLANS, H = 3' MIN., 6' MAX.
3. DRAINAGE EASEMENT REQUIRED.
4. AREA SHOWN THUS ▨ SHALL BE COMPACTED TO 90% RELATIVE DENSITY PER STANDARD SPECIFICATION 3.04.03.
5. REINFORCED BLOCK WALL AND FOOTING PERMITTED.

SAN BERNARDINO COUNTY ROAD DEPARTMENT			
DATE: J.E.M. 7-66	*M. A. Nicholas* COUNTY ENGINEER	CUTOFF WALL FOR DRAINAGE CHANNEL	200



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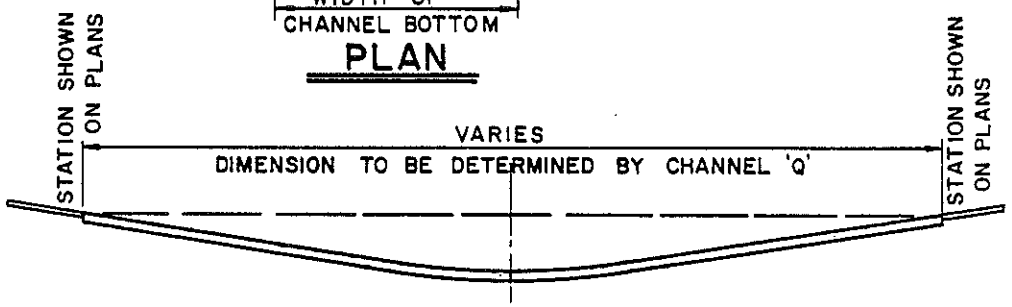
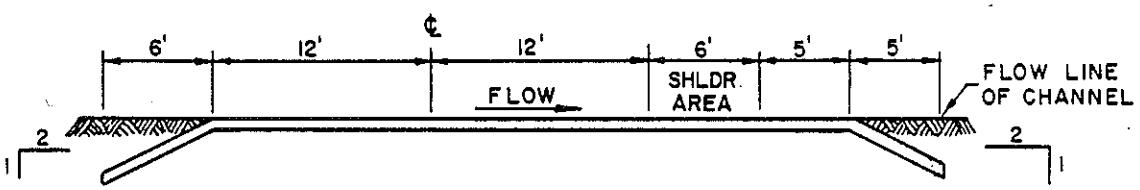
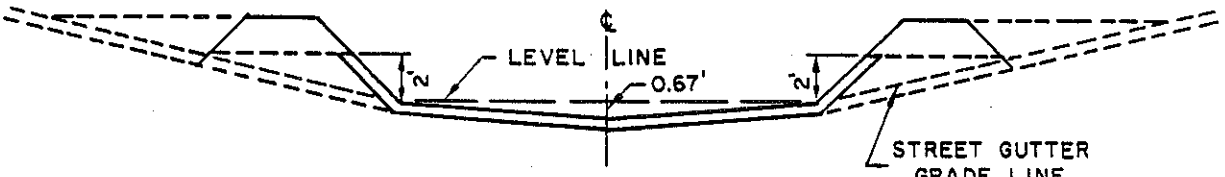


SECTION B-B



SECTION C-C



SECTION F-F

NOTE

PAVEMENT SHALL BE CONSTRUCTED OF 3" MIN. THICK ASPHALT CONCRETE.

SAN BERNARDINO COUNTY ROAD DEPARTMENT			
DATE: F.V.C. 7-65	*M. A. Nicholas* COUNTY ENGINEER	CHANNEL CROSSING	200a

EXHIBITS

SAN BERNARDINO COUNTY
FLOOD CONTROL DISTRICT
CHANNEL SECTIONS

Merrell-Johnson Engineering, Inc.
CIVIL ENGINEERING ♦ SURVEYING

SAN BERNARDINO COUNTY FLOOD CONTROL DISTRICT
DESIGN CRITERIA

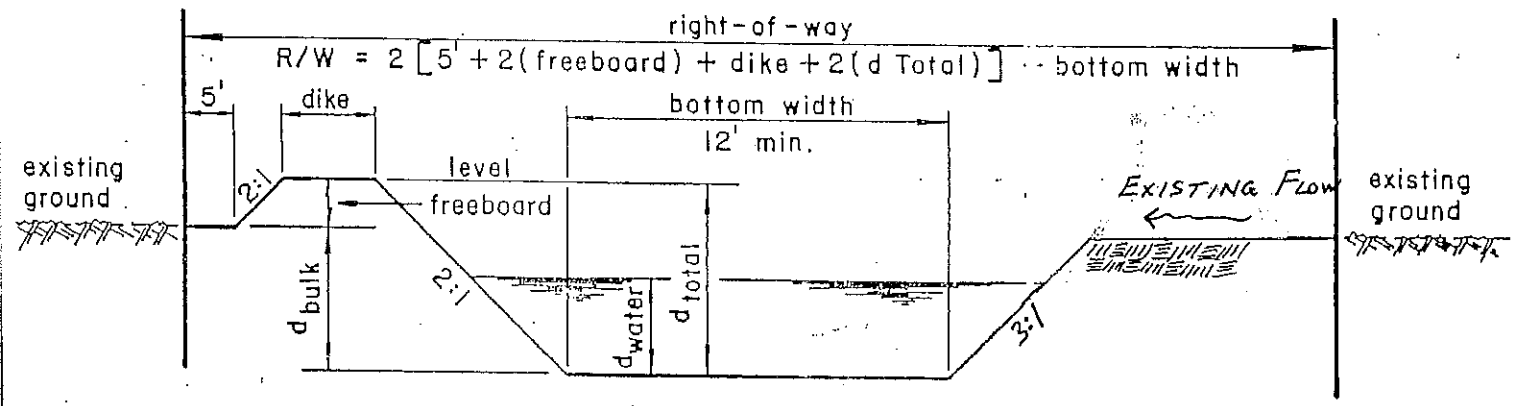
1) Hydrology calculations shall adhere to the San Bernardino County Hydrology Manual.

2) Structural calculations shall adhere to the Los Angeles County Flood Control District Structural Design Manual and to the State of California Department of Transportation Bridge Planning and Design Manuals and the Standard Plans

3) Basin structural design shall adhere to the Los Angeles County Flood Control District Design Manual for Debris Dams and Basins.

4) Hydraulic design shall adhere to the Los Angeles County Flood Control District Hydraulic Design Manual and to the State of California Department of Transportation Highway Design Manual. Lined drainage facilities shall be designed with a bulking factor of 50% increase in water depth when there are no facilities to remove debris. Closed conduit systems shall be designed with a surface backup system to handle a Q_{100} frequency storm, a bulking factor of 50% increase in Q_{100} and a debris basin system to remove debris. Culverts under roadways, except when connected to lined open channels, shall be designed in accordance with Caltrans Highway Design Manual.

5) Earth channel design shall adhere to the following:
   a) Bulk depth
      i) For graded earth channels, use $d_{bulk} = 1.5 d_{water}$.
      ii) For natural drainage courses, compute d_{bulk} based upon $Q_{bulk} = 2\ Q_{100}$
   b) For total depth use $*d_{total} = d_{bulk}$ + freeboard
      * When "V" < 6 f.p.s. - use d_{water} + 2' freeboard
        8 f.p.s. > "V" ≥ 6 f.p.s. use d_{bulk} + 2' freeboard "V" = velocity
        "V" ≥ 8 f.p.s. use d_{bulk} + 3' freeboard
   c) Dike width
      When bottom width = 12' to 40' use dike width + 15'
      bottom width = 40' or more use dike width = 18'



EARTH CHANNEL SECTION

SAN BERNARDINO COUNTY FLOOD CONTROL DISTRICT		
REVISIONS	DWN. BY	DATE
	FILE NO.	
	S.P. 100	

DIETERICH-POST CLEARPRINT 1020-10

SAN BERNARDINO COUNTY FLOOD CONTROL DISTRICT
DESIGN CRITERIA

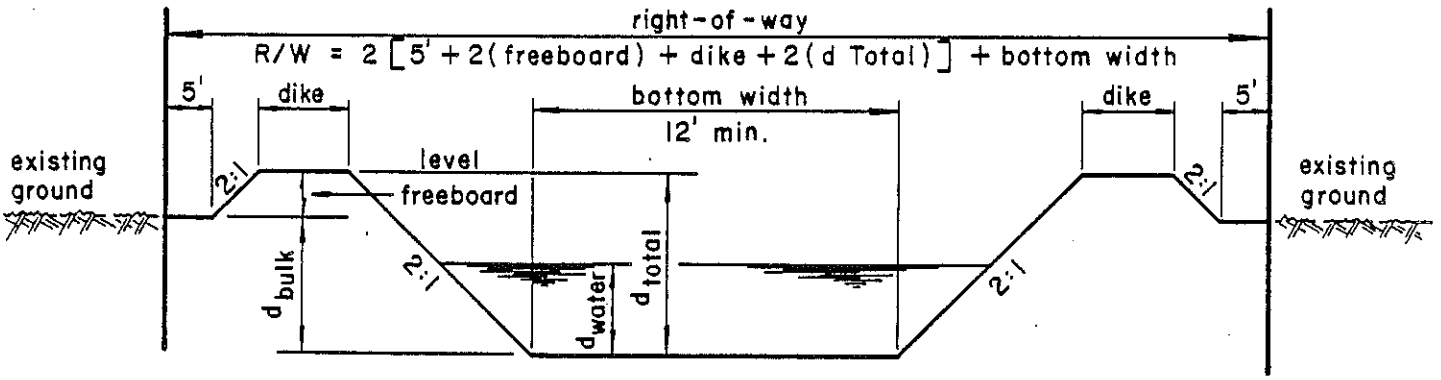
1) Hydrology calculations shall adhere to the San Bernardino County Hydrology Manual.

2) Structural calculations shall adhere to the Los Angeles County Flood Control District Structural Design Manual and to the State of California Department of Transportation Bridge Planning and Design Manuals and the Standard Plans.

3) Basin structural design shall adhere to the Los Angeles County Flood Control District Design Manual for Debris Dams and Basins.

4) Hydraulic design shall adhere to the Los Angeles County Flood Control District Hydraulic Design Manual and to the State of California Department of Transportation Highway Design Manual. Lined drainage facilities shall be designed with a bulking factor of 50% increase in water depth when there are no facilities to remove debris.
Closed conduit systems shall be designed with a surface backup system to handle a Q_{100} frequency storm, a bulking factor of 50% increase in Q_{100} and a debris basin system to remove debris. Culverts under roadways, except when connected to lined open channels, shall be designed in accordance with Caltrans Highway Design Manual.

5) Earth channel design shall adhere to the following:
   a) Bulk depth
      i) For graded earth channels, use $d_{bulk} = 1.5 d_{water}$
      ii) For natural drainage courses, compute d_{bulk} based upon $Q_{bulk} = 2\ Q_{100}$
   b) For total depth use $*d_{total} = d_{bulk}$ + freeboard
      * When "V" < 6 f.p.s. - use d_{water} + 2' freeboard
        8 f.p.s. > "V" ≥ 6 f.p.s. use d_{bulk} + 2' freeboard "V" = velocity
        "V" ≥ 8 f.p.s. use d_{bulk} + 3' freeboard
   c) Dike width
      When bottom width = 12' to 40' use dike width + 15'
      bottom width = 40' or more use dike width = 18'



EARTH CHANNEL SECTION

SAN BERNARDINO COUNTY FLOOD CONTROL DISTRICT		
REVISIONS	DWN. BY	DATE
	FILE NO.	
	S.P. 100	

DIETERICH-POST CLEARPRINT 1020-10