



HYDROLOGY STUDY

For

7.5 MW PHOTOVOLTAIC SOLAR ELECTRIC GENERATING FACILITY

APN 0466-181-059, 060, 061, & 062

San Bernardino County, CA

April 25, 2012

Prepared by:

Merrell-Johnson Companies

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Apple Valley, CA 92307
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Job No. 3158-23



Michael E. Casady 4-25-12
Michael E. Casady
Associate Engineer
R.C.E. 73156 Exp. 12/31/12

A handwritten signature in black ink that reads "Mark D. Rowan".

Mark D. Rowan
Project Manager

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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 boundaries of the proposed project site as delineated on the maps contained in this study. This study also examines measures to intercept the runoff flows and convey them through the project to their historical flow locations.

PROJECT LOCATION

The project site is located approximately 1320' East of Helendale Road, between Wild Road and Smithson Road in Helendale, an unincorporated area of the County of San Bernardino, California. The project site location is highlighted on the attached vicinity map.

METHODOLOGY

The method in determining these peak runoff flows was the rational method as outlined in the 1986 San Bernardino County Hydrology Manual. The existing offsite tributary areas were examined and delineated from U.S.G.S. Map: Wild Crossing.

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)
Node 10 – Node 11	4	921	10.0	0.0043
Node 11 – Node 12	5	2,061	60.9	0.0024

DESCRIPTION

GENERAL:

The stormwater runoff tributary to the site originates within the adjacent properties to the west of the site and crosses the western boundary of the project site. The total tributary area is approximately 71 acres.

There is very limited evidence of scour and within the areas of the watershed primarily due to the flatness of the existing terrain and previous agricultural activities within the tributary area. Runoff flow across the project area will be in the form of undefined sheet flow across the site.

EXISTING CONDITION:

The project site is located approximately 1320 feet east of Helendale Road and is bounded on the north by Wild Road and on the south by Smithson Road in Helendale, an unincorporated area of the County of San Bernardino. Wild and Smithson Roads are improved, paved roadways. The existing topography of this site slopes from the southwest towards the northeast at approximately 0.3%. The off-site tributary area is generally open, undeveloped land owned by the Helendale Community Services District and is proposed to be developed as a community services / park site. The existing vegetation on the site consists of desert brush and vegetation in sandy surface soils.

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

Table B

Off-Site Sub-Area	Q100 (cfs)
Nodes 10 – 11	17.6
Nodes 11 – 12	34.3

DEVELOPED CONDITION:

The project site will be developed as a solar array field to produce solar electricity. The collector arrays will be elevated above the ground on concrete footings and steel columns. There is no building construction planned as part of this project. Storm runoff will flow across the site in the form of sheet flow underneath the arrays. Due to their elevation, the arrays will be protected from the sheet runoff flows.

CONCLUSIONS AND RECOMMENDATIONS

During our field investigation of the site we observed the existing conditions as stated previously. The calculated 100-year storm runoff flow tributary to the western boundary of the project site is approximately 51 cubic feet per second. Runoff flow tributary to the southern boundary will be intercepted within Smithson Road and conveyed past the project site. The 100-year runoff flow crossing the boundaries of the project is tabulated in Table B above.

The tributary runoff flow will cross the site in the form of sheet flow. Due to the lack of evidence of existing scour and the flatness of the terrain, it is likely that the flow will not be concentrated and will cross the site as very shallow depth sheet flow as the historical flow in the area has been.

The site will be designed and constructed in accordance with engineered grading plans. The onsite solar arrays will be elevated above the surrounding terrain to protect them from storm runoff sheet flows within the project site area. The site will essentially remain 100% pervious due to the small footprints of the array foundations and rainfall on the arrays will flow off and percolate into the ground beneath the arrays. The historical flow parameters and flow locations will be maintained throughout the development. Sheet flows crossing the site are anticipated to be less than 3" in depth.

SECTION 2

EXHIBITS

VICINITY MAP

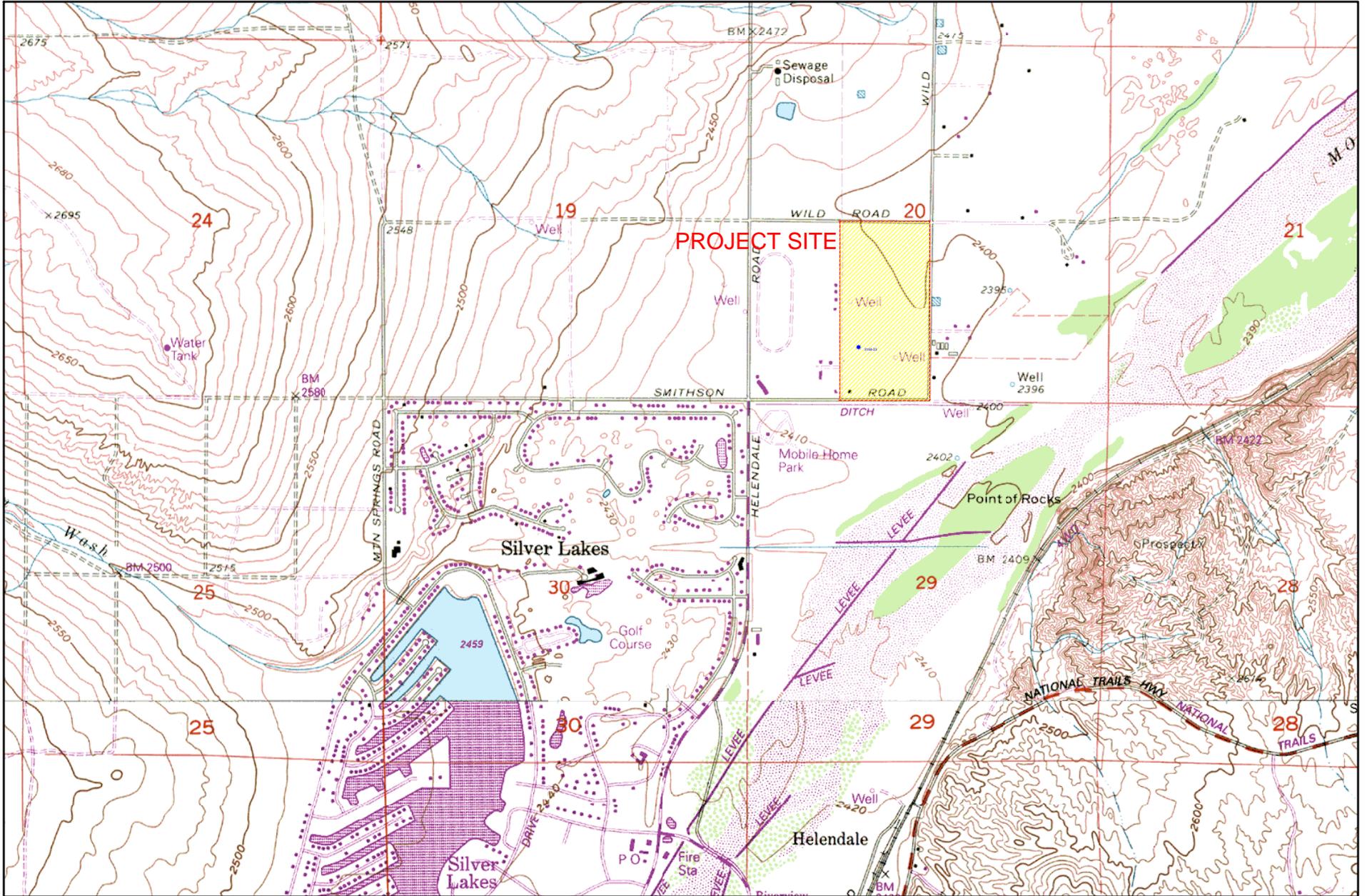


Google earth

miles
km



U.S.G.S. MAP



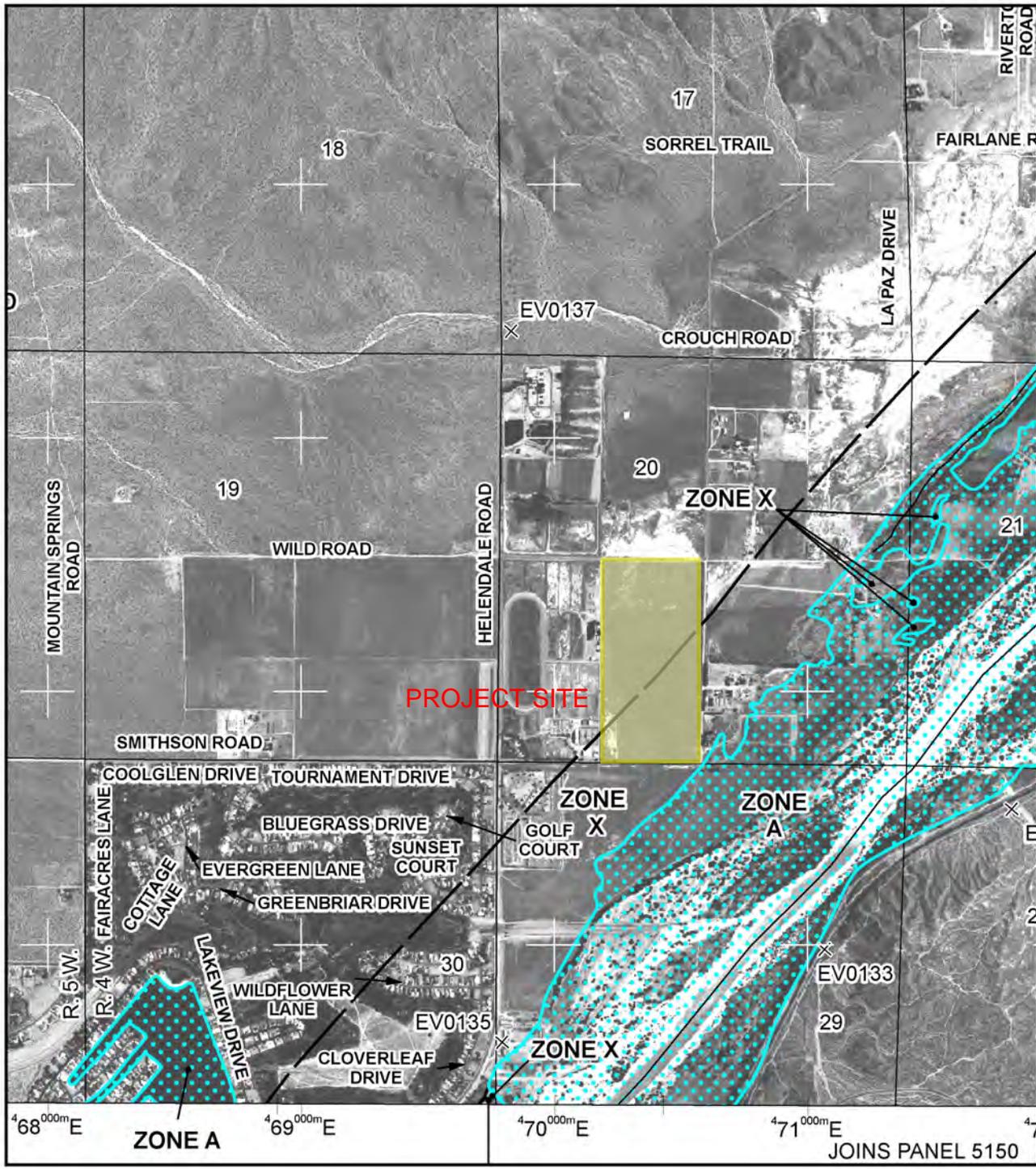
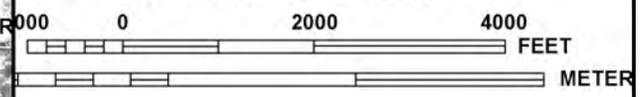
Name: WILD CROSSING
 Date: 4/25/2012
 Scale: 1 inch equals 2000 feet

Location: Sec 30 T0080N R0040W CA San Bernardino
 Caption: LANDPRO SITE 3158-23

FIRM MAP



MAP SCALE 1" = 2000'



NFIIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 4500H

FIRM
FLOOD INSURANCE RATE MAP

SAN BERNARDINO
COUNTY,
CALIFORNIA
AND INCORPORATED AREAS
PANEL 4500 OF 9400

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS

COMMUNITY	NUMBER	PANEL	SUFFIX
SAN BERNARDINO COUNTY	060270	4500	H

Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.



MAP NUMBER
06071C4500H

MAP REVISED
AUGUST 28, 2008

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

JOINS PANEL 5150

SECTION 3

HYDROLOGY CALCULATIONS

SITE MAP

7.5MW PHOTOVOLTAIC SOLAR ELECTRIC GENERATING FACILITY

- LEGEND**
- BSL INDICATES BUILDING SETBACK LINE
 - CONC. INDICATES CONCRETE
 - ELEC. INDICATES ELECTRIC
 - PP INDICATES POWER POLE
 - INDICATES EXISTING TREE
 - INDICATES EXISTING CONTOUR
 - INDICATES EXISTING POWER LINE
 - INDICATES PROPOSED 8' HIGH CHAIN LINK FENCE
 - INDICATES PROPOSED FIRE ACCESS ROAD
 - INDICATES PROPOSED SECURITY DEVICE
 - INDICATES PROPOSED BY SOLAR TRACKER
 - INDICATES PROPOSED INVERTER FIELD BOUNDARY
 - INDICATES PROPOSED PHASE BOUNDARY

LEGAL DESCRIPTION:

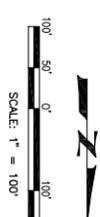
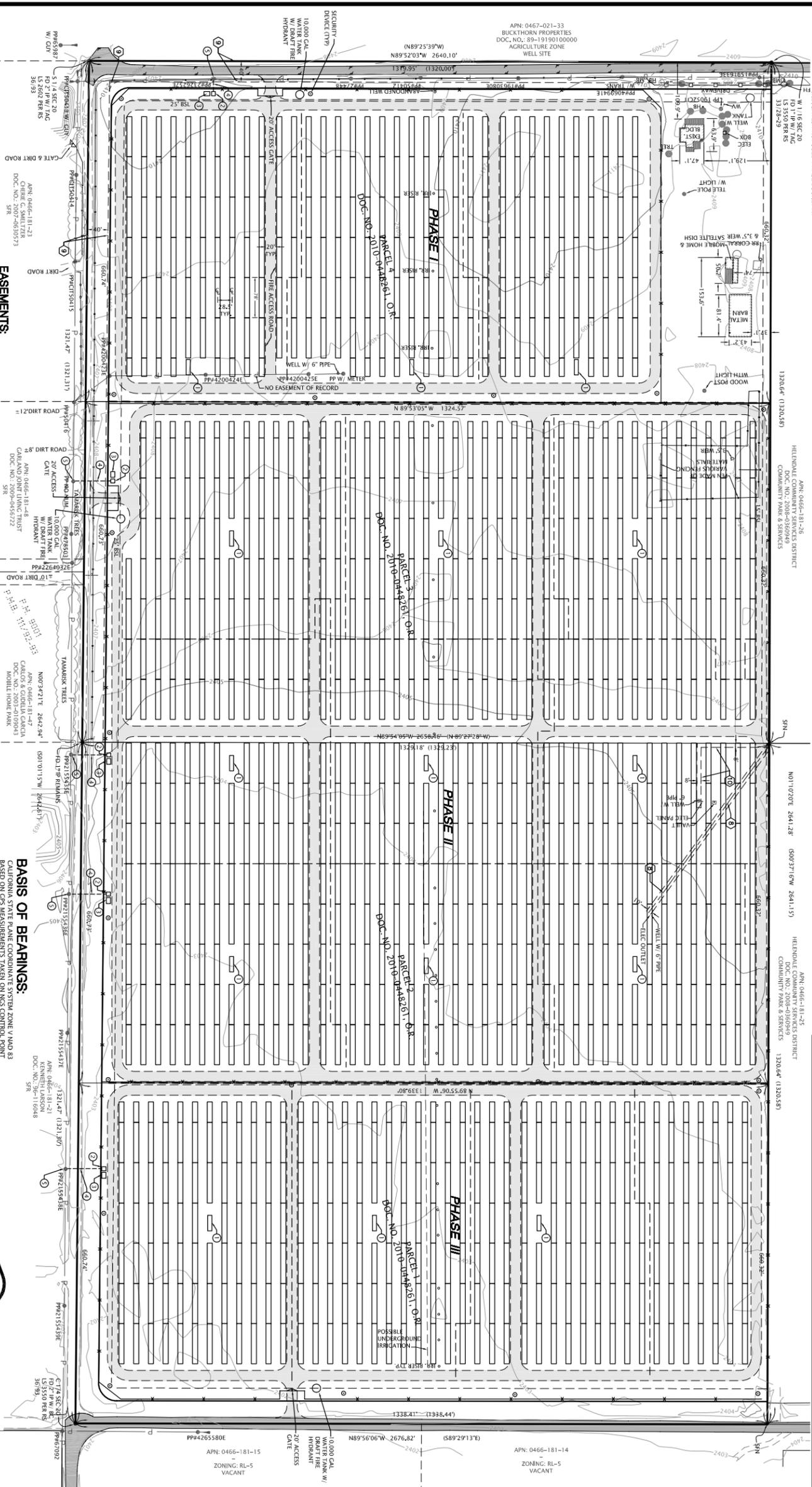
THAT PORTION OF THE EAST 1/2 OF THE SOUTHWEST 1/4 OF SECTION 20, TOWNSHIP 8 NORTH, RANGE 4 WEST, SAN BERNARDINO COUNTY, CALIFORNIA, MORE PARTICULARLY DESCRIBED AS FOLLOWS:

PART 1:
COMMENCING AT A POINT THAT IS DISTANT 1320.67 FEET SOUTH ALONG THE WESTERLY LINE FROM THE NORTHWEST CORNER OF THE WESTERLY LINE OF THE SOUTHWEST 1/4 OF SECTION 20, TOWNSHIP 8 NORTH, RANGE 4 WEST, SAN BERNARDINO COUNTY, CALIFORNIA, DISTANCE OF 1320.67 FEET MORE OR LESS TO THE EAST LINE OF SAID LAND; THENCE EASTERLY PARALLEL WITH THE WESTERLY LINE OF SAID LAND, DISTANCE OF 1329.22 FEET MORE OR LESS TO THE EAST LINE OF SAID LAND; THENCE SOUTHERLY ALONG THE WESTERLY LINE OF SAID LAND, DISTANCE OF 1329.22 FEET MORE OR LESS TO THE WESTERLY LINE OF SAID LAND; THENCE WESTERLY PARALLEL TO THE WESTERLY LINE OF SAID LAND, DISTANCE OF 1329.22 FEET MORE OR LESS TO THE POINT OF BEGINNING.

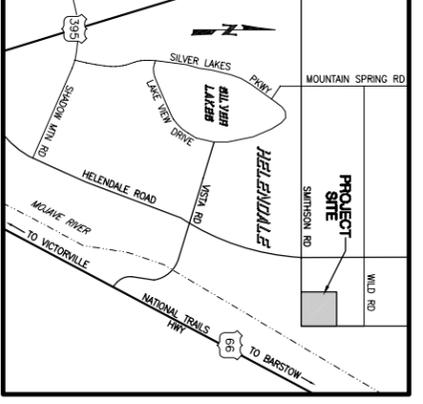
PART 2:
THAT PORTION OF THE EAST 1/2 OF THE SOUTHWEST 1/4 OF SECTION 20, TOWNSHIP 8 NORTH, RANGE 4 WEST, SAN BERNARDINO COUNTY, CALIFORNIA, MORE PARTICULARLY DESCRIBED AS FOLLOWS:

PART 3:
THAT PORTION OF THE EAST 1/2 OF THE SOUTHWEST 1/4 OF SECTION 20, TOWNSHIP 8 NORTH, RANGE 4 WEST, SAN BERNARDINO COUNTY, CALIFORNIA, MORE PARTICULARLY DESCRIBED AS FOLLOWS:

PART 4:
THAT PORTION OF THE EAST 1/2 OF THE SOUTHWEST 1/4 OF SECTION 20, TOWNSHIP 8 NORTH, RANGE 4 WEST, SAN BERNARDINO COUNTY, CALIFORNIA, MORE PARTICULARLY DESCRIBED AS FOLLOWS:



FOR OFFICIAL USE ONLY



- NOTES:**
1. PROPOSED AC SOLARON 500V (480) INVERTERS
 2. PROPOSED UTILITY METERING SECTION 1 W/ 1600A MIO
 3. PROPOSED NEW AC SERVICE TRANSFORMER 150VA (OR OTHER) 12.47-480/277V 3Ø
 4. UNDERGROUND UTILITY TRUNK
 5. ELECTRICAL TR-94 WITH SET 12KV DISTRIBUTION LINE
 6. THIS IS A TRACKING PHOTOVOLTAIC SOLAR PANEL
 7. THERE WILL BE NO UNMANNED STRUCTURES ON SITE
 8. THERE ARE NO TREES ON SITE
 9. ALL ACCESS & FIRE ROADS TO BE VANTIE MATERIAL COMPACTED TO 90% MINIMUM
 10. ALL ACCESS & FIRE ROADS TO HAVE AN INSIDE TURNING RADIUS OF 22' MINIMUM

SITE INFO:
APN: 0466-181-15
AREX: 80.6 ACRES CROSS
ZONING: RL-5

APPLICANT:
SUNLIGHT PARTNERS, LLC
4215 MC DONALD ROAD, SUITE 212
MESA, ARIZONA 85215
(480) 924-5519

OWNER:
DAVID G. FAYLOR AND
LAUREN FAYLOR
APRIL VALLEY, CALIFORNIA 92507

CIVIL ENGINEER:
MERRELL JOHNSON COMPANIES
2221 HIGHWAY 18
SAN BERNARDINO COUNTY 92507
(760) 246-8000

**CONDITIONAL USE PERMIT
SITE PLAN**
APN: 0466-181-058, 080, 091 & 092
SAN BERNARDINO COUNTY
SUNLIGHT PARTNERS, LLC

DRAWN BY:
DATE: 04/16/12
JOB NO. 3158-23
SHEET 1 OF 1



EASEMENTS:

THE EFFECTS OF ANY OF AN EASEMENT FOR PUBLIC UTILITIES AND INCENTIVE PURPOSES, RECORDED DECEMBER 20, 1972 AS BOOK 9328 PAGE 1459 OF OFFICIAL RECORDS, IN FAVOR OF CALIFORNIA ELECTRIC POWER COMPANY AFFECTS SAID LAND

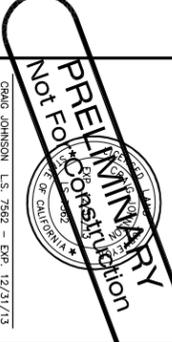
THE EFFECTS OF ANY OF AN EASEMENT FOR HIGHWAY AND INCENTIVE PURPOSES, RECORDED DECEMBER 11, 1979 AS BOOK 9577 PAGE 22 AFFECTS SAID LAND

THE EFFECTS OF ANY OF AN EASEMENT FOR PUBLIC UTILITIES AND INCENTIVE PURPOSES, RECORDED MARCH 28, 1985 AS INSTRUMENT NO. 85-77600 OF OFFICIAL RECORDS, IN FAVOR OF SOUTHERN CALIFORNIA Edison COMPANY AFFECTS SAID LAND

BASIS OF BEARINGS:

CALIFORNIA STATE PLANE COORDINATE SYSTEM ZONE V AND 83 BASED ON GPS MEASUREMENTS TAKEN ON NCS CONTROL POINT SUNNY HILL (P09E2866) AND U.S.C.G.S. BENCHMARK V 534 (P09E0157) HAVING A GRID DISTANCE OF 149525.171.

BENCHMARK:
U.S.C.G.S. BENCHMARK V 534 BRASS CAP IN CONIC MONUMENT LOCATED 2.7 MILES NORTH ALONG HARBOR LAKE ROAD (REGATED ROAD) FROM THE SOUTHWEST CORNER OF THE SOUTHWEST CORNER OF THE SECTION 20, TOWNSHIP 8 NORTH, RANGE 4 WEST, SAN BERNARDINO COUNTY, CALIFORNIA, DISTANCE OF 1.9 FEET NORTH OF A WITNESS POST, ABOUT 1 FOOT HIGHER THAN THE ROAD, AND SET IN THE TOP OF A CONCRETE MONUMENT (ELEVATION=4272.0)

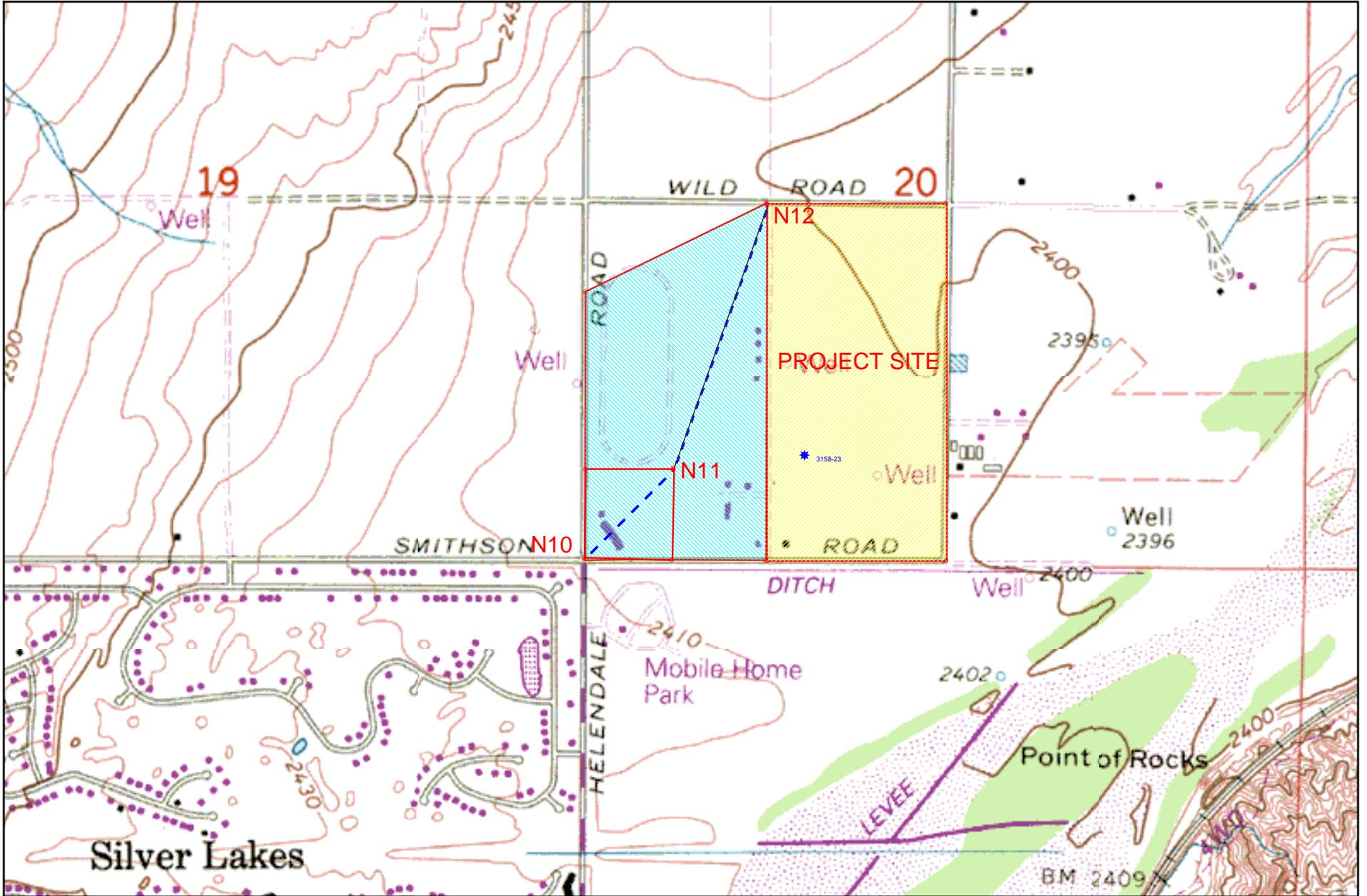


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CONSULTANTS
2221 HIGHWAY 18
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(760) 246-1400 FAX

128 E. FREDERICKS STREET
SAN BERNARDINO COUNTY 92571
(760) 252-2088
(760) 252-0418 FAX

OFF-SITE HYDROLOGY CALCULATIONS

OFF-SITE HYDROLOGY MAP



Name: WILD CROSSING
Date: 4/25/2012
Scale: 1 inch equals 1000 feet

Location: Sec 20 T0080N R0040W CA San Bernardino
Caption: LANDPRO SITE 3158-23

HYDROLOGY CALCULATIONS

RATIONAL CALCULATIONS

100-YEAR STORM

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: 04/21/12

SUNLIGHT PARTNERS - JOB NO. 3158-23
LANDPRO SITE - HELENDALE, CA
OFFSITE TRIBUTARY FLOW
100-YEAR STORM EVENT

MERRELL JOHNSON COMPANIES
22221 US HIGHWAY 18
APPLE VALLEY, CA 92307
(760) 240-8000 * FAX (760) 240-1400

***** 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 10.000 to Point/Station 11.000
**** INITIAL AREA EVALUATION ****

PARK 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) = 69.00
Pervious ratio(Ap) = 0.8500 Max loss rate(Fm)= 0.466(In/Hr)
Initial subarea data:
Initial area flow distance = 921.000(Ft.)
Top (of initial area) elevation = 2410.000(Ft.)
Bottom (of initial area) elevation = 2406.000(Ft.)
Difference in elevation = 4.000(Ft.)
Slope = 0.00434 s(%)= 0.43
TC = k(0.483)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration = 21.983 min.
Rainfall intensity = 2.423(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.727
Subarea runoff = 17.619(CFS)
Total initial stream area = 10.000(Ac.)
Pervious area fraction = 0.850
Initial area Fm value = 0.466(In/Hr)

Process from Point/Station 11.000 to Point/Station 12.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****

Depth of flow = 0.435(Ft.), Average velocity = 1.048(Ft/s)
***** Irregular Channel Data *****

Information entered for subchannel number 1 :

Point number	'X' coordinate	'Y' coordinate
1	0.00	1.00
2	20.00	0.00
3	50.00	0.00
4	70.00	1.00

Manning's 'N' friction factor = 0.035

Sub-Channel flow = 17.619(CFS)
 ' ' flow top width = 47.383(Ft.)
 ' ' velocity= 1.048(Ft/s)
 ' ' area = 16.814(Sq.Ft)
 ' ' Froude number = 0.310

Upstream point elevation = 2406.000(Ft.)
 Downstream point elevation = 2401.000(Ft.)
 Flow length = 2061.000(Ft.)
 Travel time = 32.78 min.
 Time of concentration = 54.76 min.
 Depth of flow = 0.435(Ft.)
 Average velocity = 1.048(Ft/s)
 Total irregular channel flow = 17.619(CFS)
 Irregular channel normal depth above invert elev. = 0.435(Ft.)
 Average velocity of channel(s) = 1.048(Ft/s)

+++++

Process from Point/Station 11.000 to Point/Station 12.000
 **** SUBAREA FLOW ADDITION ****

PARK subarea

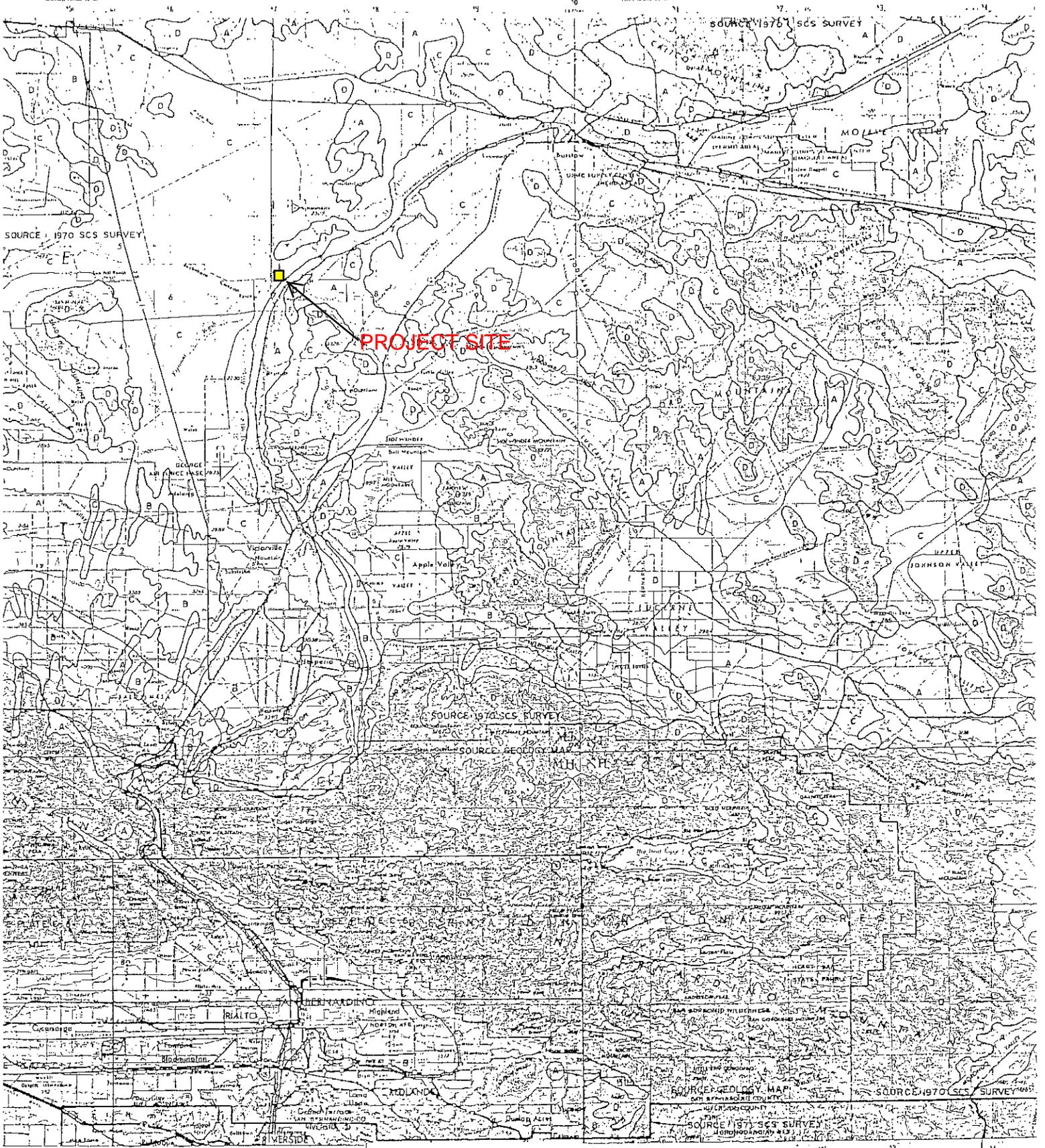
Decimal fraction soil group A = 0.000
 Decimal fraction soil group B = 0.000
 Decimal fraction soil group C = 1.000
 Decimal fraction soil group D = 0.000
 SCS curve number for soil(AMC 2) = 69.00
 Pervious ratio(Ap) = 0.8500 Max loss rate(Fm)= 0.466(In/Hr)
 Time of concentration = 54.76 min. Tc
 Rainfall intensity = 1.279(In/Hr) for a 100.0 year storm
 Effective runoff coefficient used for area,(total area with modified
 rational method)(Q=KCIA) is C = 0.572
 Subarea runoff = 34.289(CFS) for 60.900(Ac.)
 Total runoff = 51.908(CFS) Q₁₀₀
 Effective area this stream = 70.90(Ac.)
 Total Study Area (Main Stream No. 1) = 70.90(Ac.)
 Area averaged Fm value = 0.466(In/Hr)
 End of computations, Total Study Area = 70.90 (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) = 0.850
 Area averaged SCS curve number = 69.0

EXHIBITS

SOILS MAP



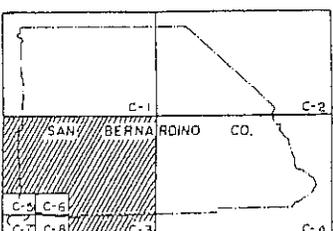
SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

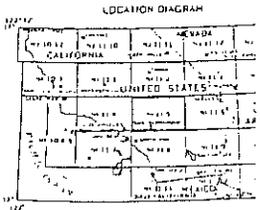
HYDROLOGIC SOILS GROUP MAP

FOR

SOUTHCENTRAL AREA

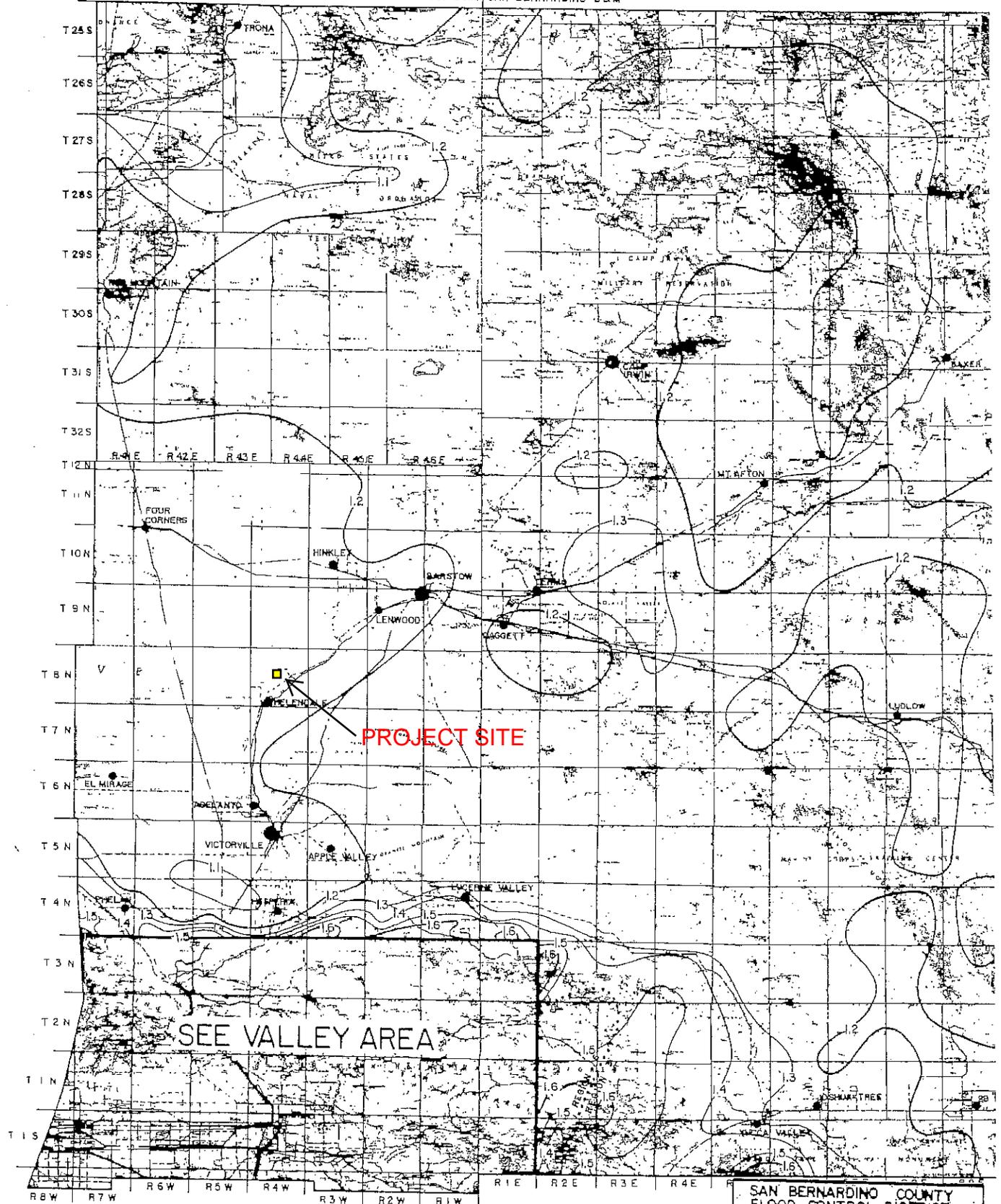


INDEX MAP



LOCATION DIAGRAM

ISOHYETAL MAP



SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

SAN BERNARDINO COUNTY FLOOD CONTROL DISTRICT			
DESERT AREA			
ISOHYETALS Y ₁₀₀ -100 YEAR 1 HOUR BASED ON U.S.G.C. NOAA ATLAS 2, 1973			
APPROVED BY			
DATE	SCALE	FILE NO.	PRINT NO.