PRELIMINARY
DRAINAGE
REPORT
BOWMAN TRAIL/TR. No. 11331
LANDERS, CA
COUNTY OF
SAN BERNARDINO
April 24, 2014

Prepared by:

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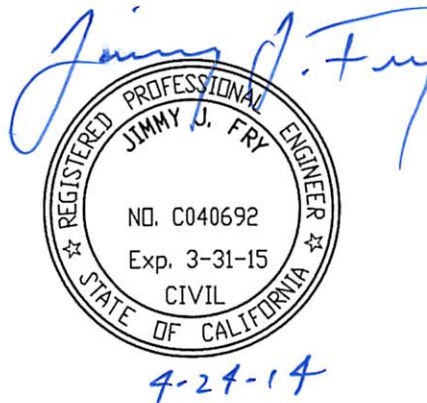Phone 928-768-1857 Fax 928-768-7086

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PRELIMINARY
DRAINAGE REPORT BOWMAN TRAIL/TR. No. 11331
LANDERS, CA

For
APN's
0630-351-01 Thru 0630-351-15

Prepared for:
Sustainable Power Group, LLC
2949 E. Parley's Way, Ste. 310
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(801) 679-3500

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San Bernardino, CA 92410
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REGISTERED PROFESSIONAL ENGINEER
JIMMY J. FRY
NO. C040692
Exp. 3-31-15
CIVIL
STATE OF CALIFORNIA

4-24-14

Report Preparation Date
April 24, 2014

TABLE OF CONTENTS

DISCUSSION AND SUMMARY

INTRODUCTION:
The purpose of this study is to analyze existing drainage patterns in and around the proposed solar project site. The Site is part of existing Tract No. 11331, the property is currently vacant & not in use. The project is bounded on the north by Herdmans Road (dirt road), on the east by Sunny Vista (dirt road), on the south by Sespe Street & Summers Road (dirt road), and on the west by Bowman Trail (dirt road).

OVERALL HYDROLOGY:

The offsite run-offs flows in the northeasterly direction, and is presently conveyed through the existing natural flowlines, generating a drainage tributary Areas 1 & 2 (23.2 acres) Q_{100}= 30.9 cfs node 3, Areas 6 & 7 (27.1 0.acres) Q_{100}= 33.5 cfs node 9, and Areas 9 & 10 (32.9 acres) $Q100$= 36.7 cfs node 12 to project boundary.

ONSITE HYDROLOGY:

Onsite analysis involves determining pre-development storm run-off, and post-development storm runoff and mitigation measures. The existing site will be mostly undisturbed except for access roads and the switchyard location, which will be compacted native soil, and will be a gravel strip around the perimeter of site. Offsite runoffs will be conveyed through existing natural and historical flowlines as shown on the "Undeveloped Onsite/Offsite Watershed DRAINAGE MAP". Since the onsite area will not be disturbed other than the access roads and the switchyard location as impervious, which amounts to about 3.6 acres or 10 % of entire project, this is a conservative percentage since the compacted road will have some permeability, given us a post-developed Q100 of 189.1 cfs compared to pre-developed Q100 of 170.1 cfs. A 20 feet wide gravel strip around the project will mitigate some runoff and erosion control as well as a WQMP.

HYDROLOGY METHODOLOGY:

The calculated run-off flows are depicted on the enclosed Drainage Maps. All run-off values are calculated using the rational method as outlined in the 1986 San Bernardino County Hydrology Manual, assuming:
a)   100 year storm frequency.
b)   1-hour rainfall intensity = 1.3 in/hr.
c)   Slope on the intensity duration curve = 0.70
d)   Undeveloped Average Cover
e)   Hydrologic Soils Group "B"

All flows were calculated using "RSBC.EXE", a San Bernardino County Rational Hydrology Program by Civilcadd/Civildesign engineering software, version 7.0, 1989-2004.

HYDRAULIC METHODOLOGY:

All computed depths of flow were based on the manning's equation. Various interior and perimeter conveyance flow sections were checked for adequate hydraulic capacity, per rational method calculations report.

Manning calculations for typical flow sections capacities are based on the following:

1. Design flows and street slopes per various drainage maps;
2. A manning's roughness coefficient of 0.020 for the natural dirt channels.

CONCLUSION:

Detailed analysis indicated that a 100-year, 1-hour storm event over the fully developed onsite watershed will not produce significant peak flows greater than the existing condition and that can be conveyed by the interior existing natural flowlines and mitigated per gravel perimeter strip.

WARREN VISTA AV
WARREN VISTA WY
H6E
PIPES WASH
PIPES WASH
APPLEGATE WY

HILTON AV
WINTERS RD
BOO LN
ROCKY ACRES
JACK RABBIT LN
BEARING TREE LN
6
APPLEGATE WY

SURREY AV
RAINBOW AV
SINGLE TREE
OBISPO RD
NAPA RD
FORDOM RD
AMARGO RD
BALLARD LN
7
LANDERS LN

30
19
BALSA AV
BALSA AV
18
57200

BALSA AV
GEORGE LN
BEARING TREE LN

LANDERS LN
500
300
500
700
BARTER RD
58000 57750
JUDY LN
DE FEVER LN
CAMALOS RD
DE FEVER LN

HANFORD AV
POLANDS WY
BURKE RD
LANDERS
BECKER AV

LA HABRA AV
GOAT MOUNTAIN RD
ARCHER RD
MARGARETA ST
RIO SONORA
LUTZ RD
GIBRALTAR ST
92285
JOSIAH RD
STEARMAN RD
APPLEGATE WY

HARMONY RD
58300
AVALON AV
AVALON AV
GOAT MOUNTAIN RD
PECK RD
COLUMBUS RD
COLUMBUS RD

AVALON AV
900
RECHE RD
8
5
GOAT MOUNTAIN RD
PHILLIP LN
IRA LN
APPLEGATE WY

92284
NORGO ST
NAPA RD
17
WADE TR
LUTZ RD
GOAT MOUNTAIN RD
YUCCA MESA RD
YU

29
20
WINTERS RD
58100
YUCCA MESA RD

PIONEER RD
NAPA RD
ANITA AV
SEE MAP D

BONITA AV
59400
INEZ AV
59600
ALTA AV
ALTA AV
4

28
21
NAPA RD
ALTA AV
16
SESPE ST
COVELO AV
STEARMAN RD
9
PHILLIP LN
59800
MOTT RD

WINTERS RD
GERBER AV
REILLY
LUTZ RD

DUCOR AV
KUNA AV
KUNA AV

NASON-DIXON RD
KUNA AV
NAPA RD
KUNA AV
INDIAN AV
60000
3

CHEBUR RD
MALLOW DR
60200

MALLON RD
HANDLEY RD
MALLOW DR
BOOTH AV
10
60400

DUCEYS PL
MELIZ RD
WILLIE WY
ROBINSON
BOWMAN TR
NAPA RD
RECHE RD

BOWMAN TR
22
BRIDGES LN
HEATHER DR
RANCHO VISTA DR
15
SESPE ST
LIVERY RD
BELLWETHER RD
HENDRIKS RD
STAGEMANS RD
BOURBON ST
STEARMAN RD
COLE LN

27
STARFIRE WINTERS RD
92252
BEENE LN
LUMPKIN LN
FAIRACRES LN
BURKE RD
STABLE RD
FELTLOCK RD
SUNNY VISTA RD
SUNNY VISTA RD

LAMBERT LN
RED DR
RUBY LN
LAMBERT LN
STABLE RD
SUNNY VISTA RD
WASSAL
92278

SUNNY VISTA RD
WINTERS RD
SUNNY VISTA RD
MERCURY DR
HANDLEY RD
11

JUNIPER RD
NEPTUNE DR
JUNIPER RD
NAPA RD

26
SADDLEBACK RD
SADDLEBACK AV
MERCURY DR
SUNNY HILL AV
23
VENUS DR
SATURN DR
ORION DR
MARS DR
14
SESPE ST
TWENTYNINE PALMS MARINE CORPS BASE

TR 11331
PROJECT SITE
SUNNY VISTA RD
WINTERS RD

BOWMAN SOLAR
PV SOLAR PROJECT
SAN BERNARDINO COUNTY, CA

3 MW AC SINGLE AXIS TRACKER SYSTEM
PHOTOVOLTAIC SOLAR ARRAY
DESIGN GENERAL INFORMATION

"OFFICE USE ONLY"

VICINITY MAP

BOWMAN SOLAR SITE

AGENCY CONTACTS

COUNTY:

SAN BERNARDINO COUNTY
909-387-8311

FIRE:

HOMESTEAD VALLEY/LANDERS
55481 JESSIE ROAD
LANDERS, CA 92285
PHONE: 760-364-3211

SITE INFORMATION

PROPERTY OWNERS

SUSTAINABLE POWER GROUP
2749 E. PARLEY'S WAY
SUITE 310
SALT LAKE CITY, UT 84109

MABBET FAMILY TRUST
1968 CIRCLE PARK LANE
ENCINATAS, CA 92024

PROJECT APPLICANT

SUSTAINABLE POWER GROUP
2749 E. PARLEY'S WAY
SUITE 310
SALT LAKE CITY, UT 84109

ACCESS NOTES:

THE PROPERTY CURRENTLY HAS
FULL ACCESS TO BOWMAN TRAIL,
HERDMANS ROAD, AND SUNNY
VISTA ROAD.

LEGAL DESCRIPTION

LOTS 49-63 OF TRACT NO. 11331 IN
THE COUNTY OF SAN BERNARDINO,
STATE OF CALIFORNIA, AS PER PLAT
RECORDED IN BOOK 158 OF MAPS,
PAGES 8 TO 16, INCLUSIVE, RECORDS
OF SAID COUNTY.

UTILITY NOTES:

1. NO ONSITE WATER SERVICE
    WILL BE REQUIRED.
2. NO ONSITE SEWER WILL BE
    REQUIRED.
3. NO ONSITE GAS WILL BE
    REQUIRED.
4. NO ONSITE TELEPHONE WILL BE
    REQUIRED
5. NO ONSITE CABLE TV WILL BE
    REQUIRED.
6. ELECTRICITY PROVIDED BY SCE.

FLOOD ZONE NOTE:

UNIDENTIFIED FEMA FLOOD ZONE AS
PER FEMA MAP NO. 06071C7425H.

ASSESSORS PARCEL NUMBERS/OWNER:

0630-351-01
0630-351-02
0630-351-03
0630-351-04
0630-351-05
0630-351-06
0630-351-07
0630-351-08
0630-351-09
0630-351-10
0630-351-11
0630-351-12
0630-351-13
0630-351-14
0630-351-15

TOTAL ACREAGE = 34.23 ACRES.

COORDINATE DATUM:

HARN/CA CALIFORNIA STATE PLANE,
ZONE V, US FOOT

NORTHERN ENERGY
& POWER LLC

LOCAL JOB NUMBER:
106

PROJECT TITLE:
BOWMAN SOLAR
3 MWAC
SAN BERNARDINO
COUNTY, CA

SHEET TITLE:
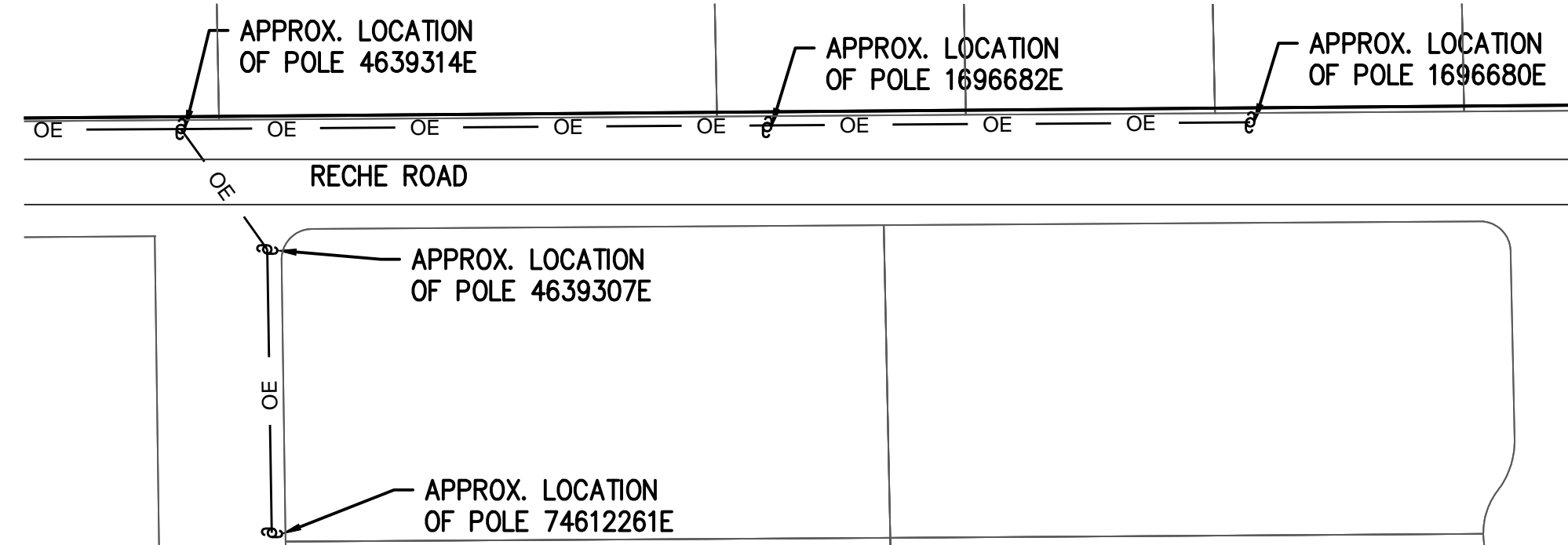PV SOLAR PROJECT
GENERAL
INFORMATION
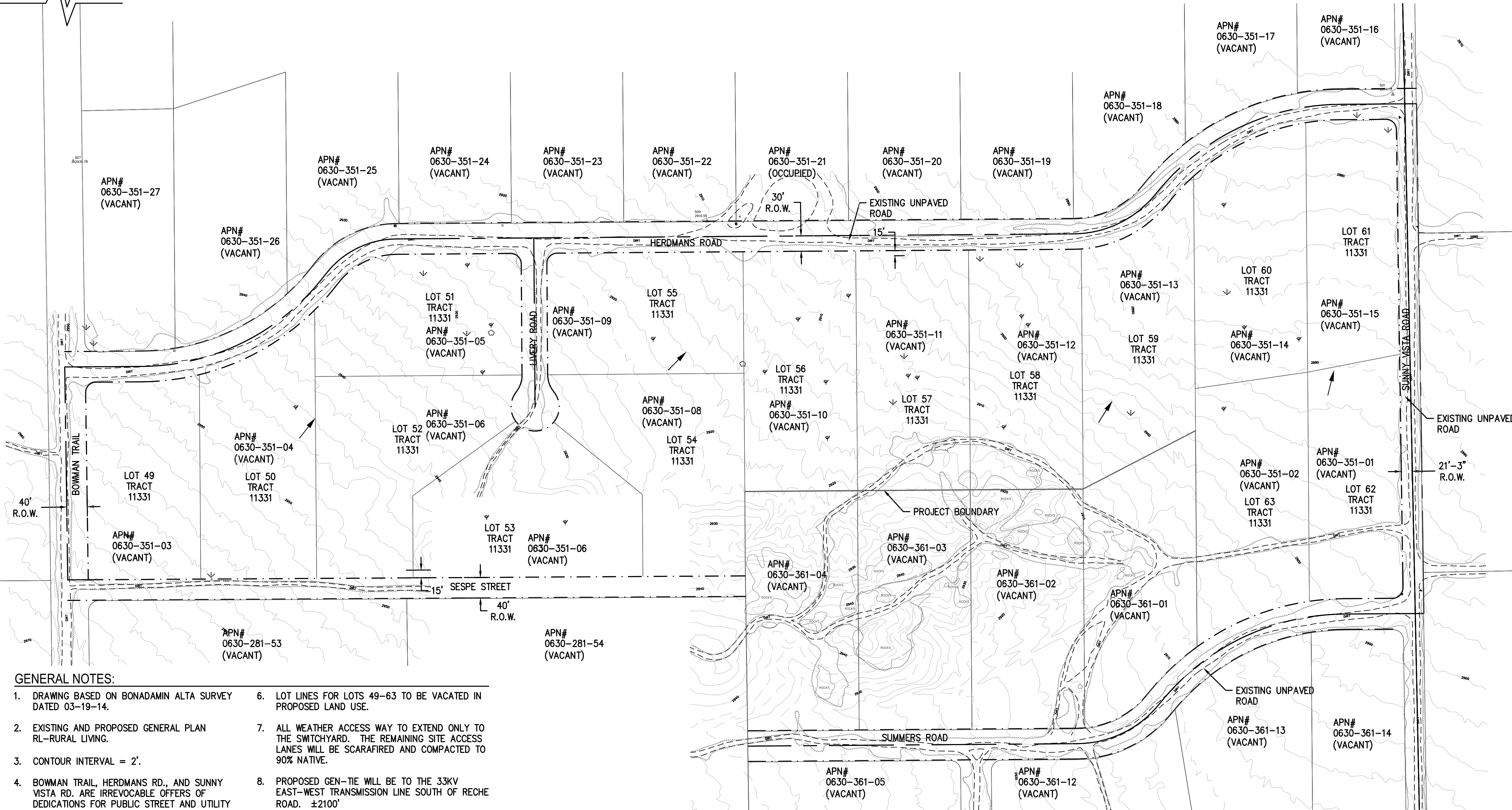
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REVISION:
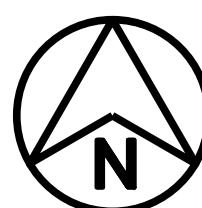A

DOCUMENT SIZE:
ARCH D (24X36)

LEGEND

————	PROPERTY LINES
------	EXISTING CONTOUR LINE
– – – –	EXISTING DIRT/FIELD ROAD
————	EXISTING PAVEMENT ROAD
—·—·—	RIGHT OF WAY
—— ——	R.O.W CENTERLINE
⌀	UTILITY POLE
OE	OVERHEAD ELECTRIC
⚑	JOSHUA TREE
⌄	BRANCHED PENCIL CHOLLA
☁	COTTONTOP CACTUS

RECHE ROAD

APPROX. LOCATION OF POLE 4639314E
APPROX. LOCATION OF POLE 1696682E
APPROX. LOCATION OF POLE 1696680E
APPROX. LOCATION OF POLE 4639307E
APPROX. LOCATION OF POLE 74612261E

APN# 0630-351-27 (VACANT)
APN# 0630-351-26 (VACANT)
APN# 0630-351-25 (VACANT)
APN# 0630-351-24 (VACANT)
APN# 0630-351-23 (VACANT)
APN# 0630-351-22 (VACANT)
APN# 0630-351-21 (OCCUPIED)
APN# 0630-351-20 (VACANT)
APN# 0630-351-19 (VACANT)
APN# 0630-351-18 (VACANT)
APN# 0630-351-17 (VACANT)
APN# 0630-351-16 (VACANT)

30' R.O.W.
EXISTING UNPAVED ROAD
15'
HERDMANS ROAD

LOT 51 TRACT 11331
APN# 0630-351-09 (VACANT)
LOT 55 TRACT 11331
APN# 0630-351-05 (VACANT)
APN# 0630-351-13 (VACANT)
LOT 60 TRACT 11331
LOT 61 TRACT 11331
APN# 0630-351-15 (VACANT)

AVERY ROAD
SUNNY VISTA ROAD

APN# 0630-351-04 (VACANT)
LOT 52 TRACT 11331
APN# 0630-351-06 (VACANT)
APN# 0630-351-08 (VACANT)
LOT 56 TRACT 11331
APN# 0630-351-10 (VACANT)
LOT 57 TRACT 11331
APN# 0630-351-11 (VACANT)
APN# 0630-351-12 (VACANT)
LOT 58 TRACT 11331
LOT 59 TRACT 11331
APN# 0630-351-14 (VACANT)

BOWMAN TRAIL

LOT 49 TRACT 11331
LOT 50 TRACT 11331
LOT 54 TRACT 11331
EXISTING UNPAVED ROAD

40' R.O.W.
APN# 0630-351-03 (VACANT)
LOT 53 TRACT 11331
APN# 0630-351-06 (VACANT)
APN# 0630-351-02 (VACANT)
APN# 0630-351-01 (VACANT)
LOT 62 TRACT 11331
21'-3" R.O.W.
LOT 63 TRACT 11331

PROJECT BOUNDARY
APN# 0630-361-03 (VACANT)
APN# 0630-361-04 (VACANT)
APN# 0630-361-02 (VACANT)
APN# 0630-361-01 (VACANT)

15' SESPE STREET
40' R.O.W.

APN# 0630-281-53 (VACANT)
APN# 0630-281-54 (VACANT)

EXISTING UNPAVED ROAD
APN# 0630-361-13 (VACANT)
APN# 0630-361-14 (VACANT)

SUMMERS ROAD

APN# 0630-361-05 (VACANT)
APN# 0630-361-12 (VACANT)

GENERAL NOTES:

1. DRAWING BASED ON BONADAMIN ALTA SURVEY DATED 03-19-14.

2. EXISTING AND PROPOSED GENERAL PLAN RL-RURAL LIVING.

3. CONTOUR INTERVAL = 2'.

4. BOWMAN TRAIL, HERDMANS RD., AND SUNNY VISTA RD. ARE IRREVOCABLE OFFERS OF DEDICATIONS FOR PUBLIC STREET AND UTILITY PURPOSES.

5. ALL LOTS IN THE PROPOSED PROJECT ARE VACANT.

6. LOT LINES FOR LOTS 49-63 TO BE VACATED IN PROPOSED LAND USE.

7. ALL WEATHER ACCESS WAY TO EXTEND ONLY TO THE SWITCHYARD. THE REMAINING SITE ACCESS LANES WILL BE SCARAFIRED AND COMPACTED TO 90% NATIVE.

8. PROPOSED GEN-TIE WILL BE TO THE 33KV EAST-WEST TRANSMISSION LINE SOUTH OF RECHE ROAD. ±2100'

9. ALL PLANTS AND TREES SUBJECT TO SAN BERNARDINO PLANT PROTECTION AND MANAGEMENT ORDINANCE WILL BE RELOCATED OR REMOVED IF LOCATED WITHIN THE FACILITY FOOTPRINT.

EXISTING SITE PLAN
SCALE: 1" = 100'-0"

100' 50' 0 100' 200'

N

NORTHERN ENERGY & POWER LLC

LOCAL JOB NUMBER: 106

PROJECT TITLE:
BOWMAN SOLAR
3 MWAC
SAN BERNARDINO
COUNTY, CA

SHEET TITLE:
CUP SINGLE EXISTING CONDITIONS SITE PLAN
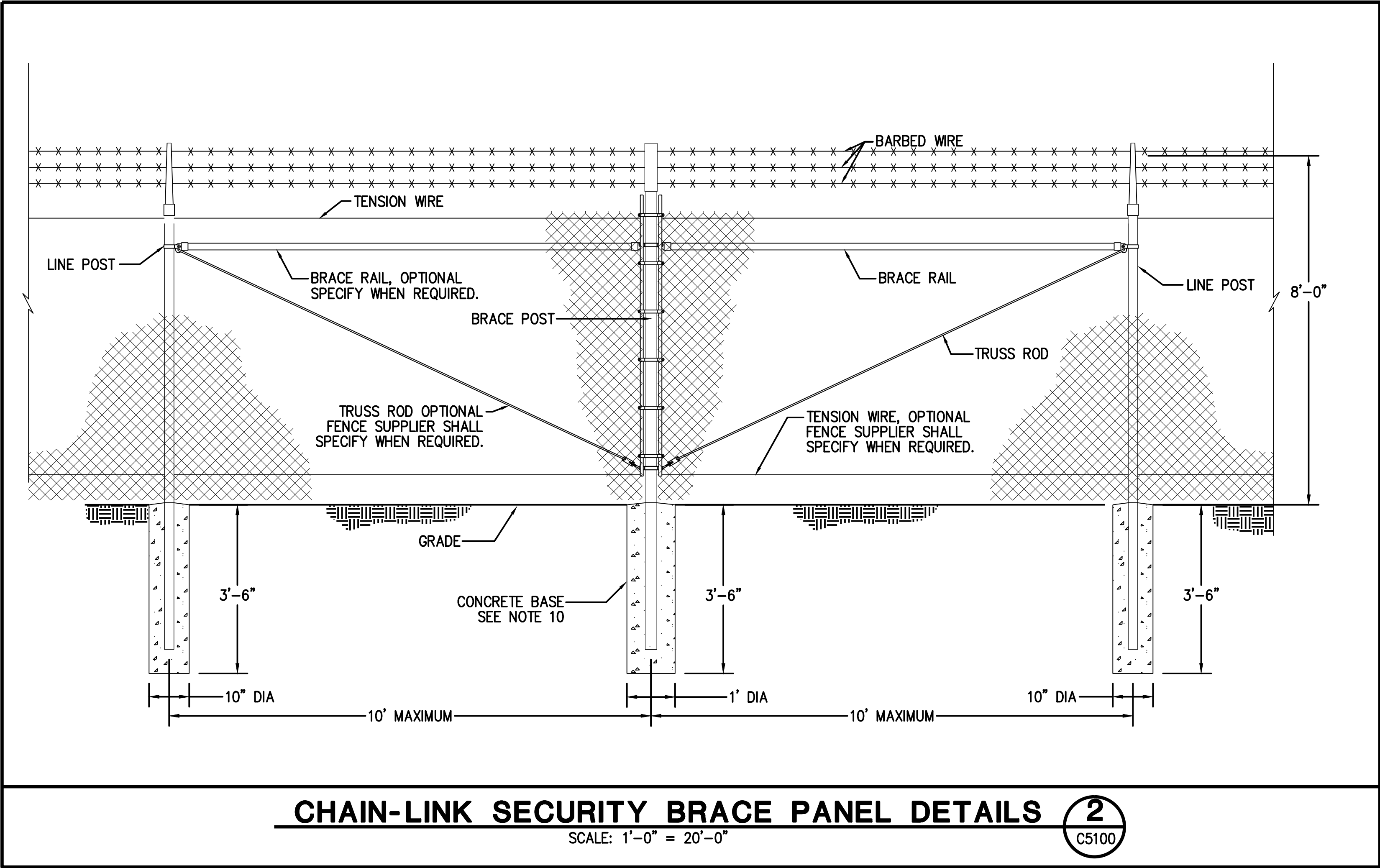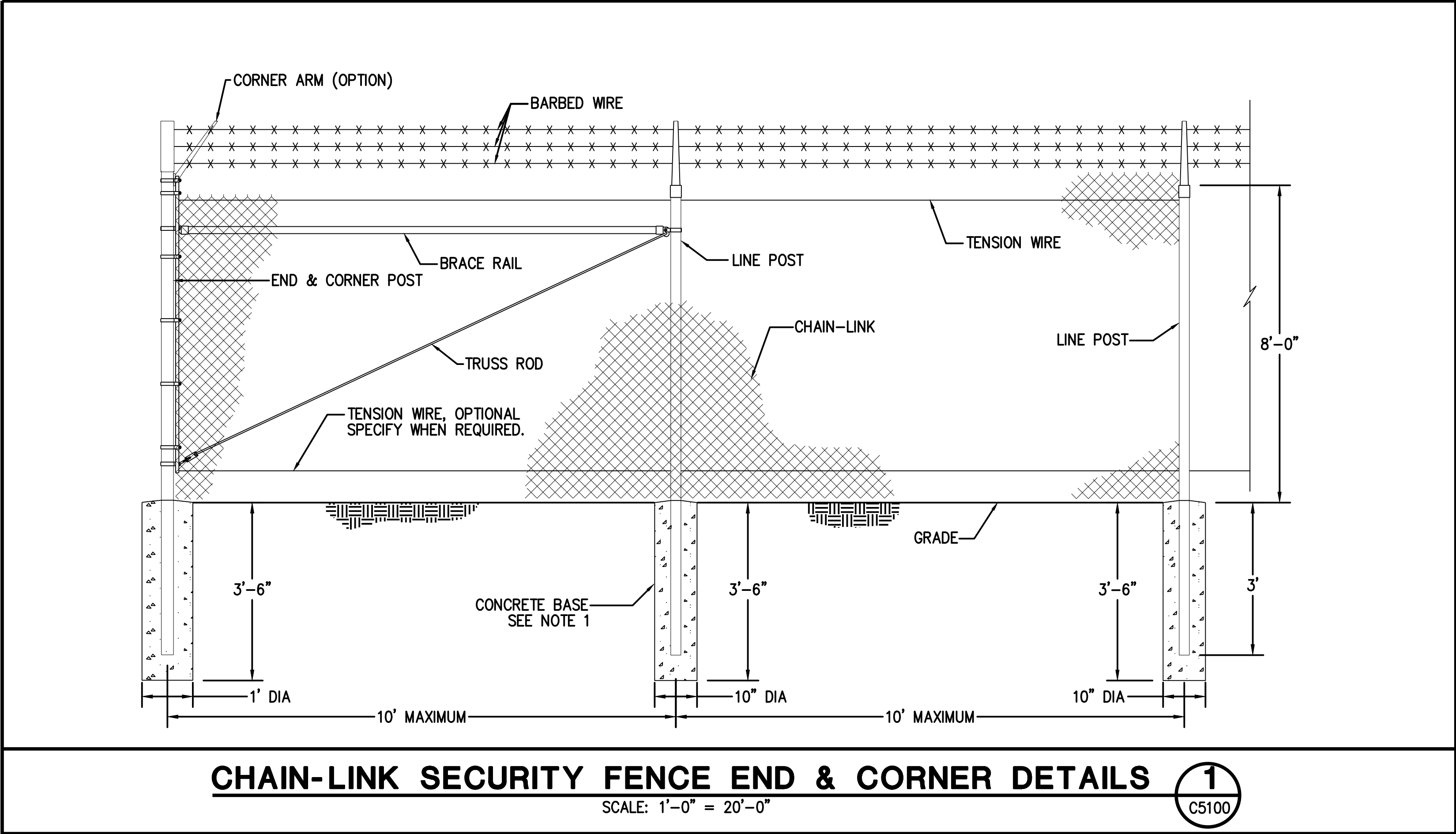
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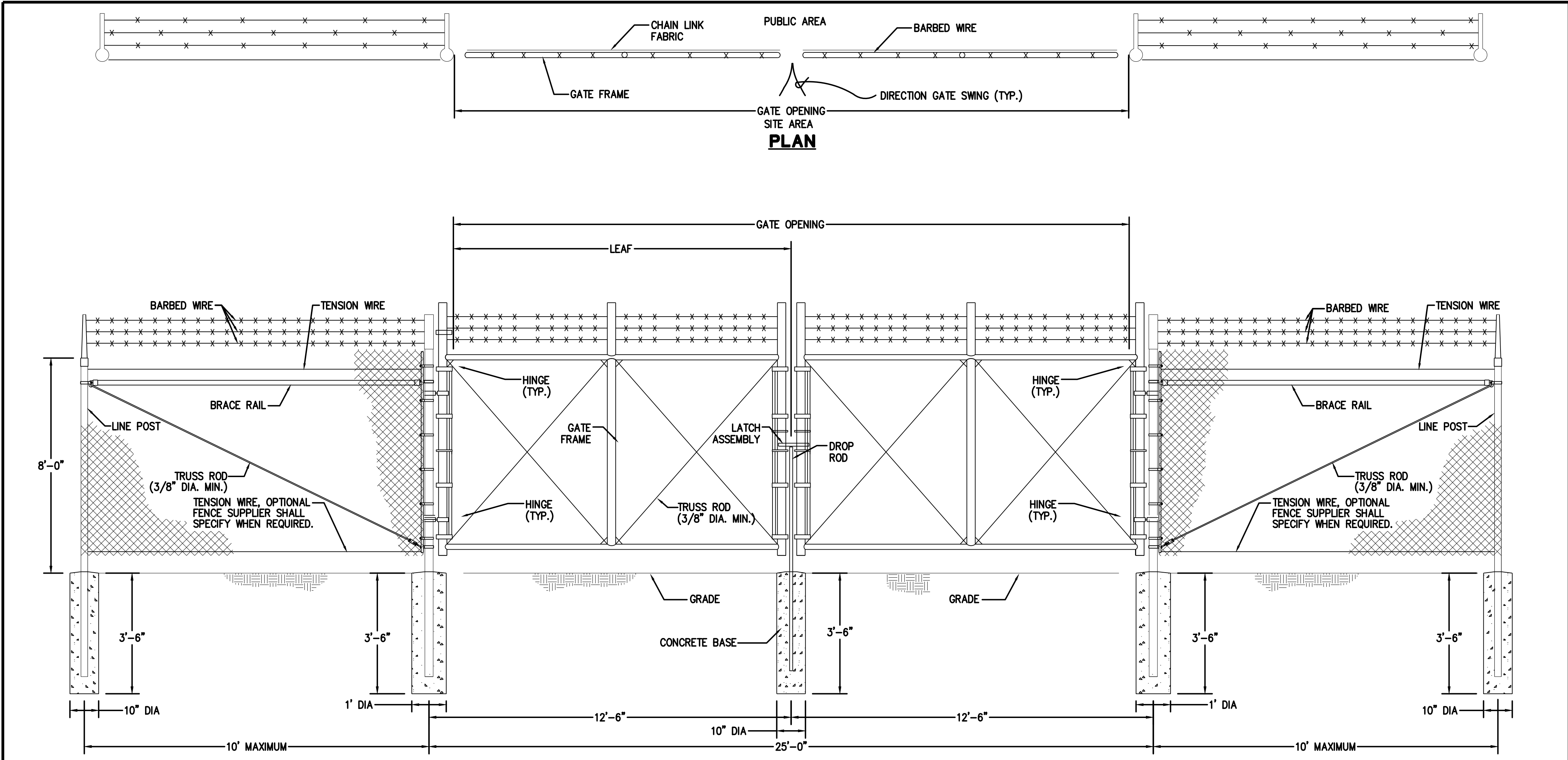REVISION: A

DOCUMENT SIZE: ARCH D (24X36)

LEGEND

Symbol	Description
	SITE PROPERTY LINE
	FENCE LINE
	GATES
	EXISTING CONTOUR LINE
	EXISTING DIRT/FIELD ROAD
	PROPOSED SITE ACCESS WAY
	ALL WEATHER ACCESS WAY
	RIGHT OF WAY
	R.O.W CENTERLINE
	UTILITY POLE
OE	OVERHEAD ELECTRIC
UG E	UNDERGROUND ELECTRIC

"OFFICE USE ONLY"

RECHE ROAD

APPROX. LOCATION OF POLE 4639314E (PROPOSED POI)
APPROX. LOCATION OF POLE 1696682E
APPROX. LOCATION OF POLE 1696680E
APPROX. LOCATION OF POLE 4639307E
APPROX. LOCATION OF POLE 74612261E

APPROXIMATE LOCATION OF PROPOSED GEN-TIE LINE.

APN# 0630-351-27 (VACANT)

BOWMAN TRAIL FROM RECHE ROAD TO HERDMANS ROAD TO BE IMPROVED AS PART OF PROJECT

PROPERTY BOUNDARY N:1921064.00 E: 7062469.17

ALL WEATHER ACCESS WAY

KNOX BOX LOCATED AT FRONT GATE

PROPERTY BOUNDARY N:1921043.72 E: 7062449.31

ENTRANCE GATE

PROPOSED SWITCHYARD

PROPERTY BOUNDARY N:1920678.58 E: 7062454.42

APN# 0630-281-53 (VACANT)

40' R.O.W.
136'-5"
15'

26' TYPICAL EXTERIOR ACCESS WAY

BLOCK 1-1

BLOCK 1-2
BLOCK 1-3
BLOCK 2-1

R20' (TYP. IR) 20'

PROPERTY BOUNDARY N:1921313.16 E: 7063055.25

APN# 0630-351-25 (VACANT)
APN# 0630-351-24 (VACANT)
APN# 0630-351-23 (VACANT)
APN# 0630-351-22 (VACANT)
APN# 0630-351-21 (OCCUPIED)
APN# 0630-351-20 (VACANT)
APN# 0630-351-19 (VACANT)
APN# 0630-351-26 (VACANT)

53'-9"

HERDMANS ROAD

GFID 5629
GFID 5777

30' R.O.W.
15'

EXISTING UNPAVED ROAD TO REMAIN

PROPERTY BOUNDARY N:1921323.09 E: 7064376.68

PROPERTY BOUNDARY N:1921465.48 E: 7064610.16

APN# 0630-351-18 (VACANT)

APN# 0630-351-17 (VACANT)
APN# 0630-351-16 (VACANT)

PROPERTY BOUNDARY N:1921576.44 E: 7064985.56

PROPERTY BOUNDARY N:1921556.73 E: 7065005.71

R46' (TYP. OR)

41'-8"

15'

SUNNY VISTA ROAD

PROPOSED CHAIN LINK FENCE WITH BARBED WIRE

26'

PROJECT BOUNDARY

PROPERTY BOUNDARY N:1920856.19 E: 7064394.81

54'-7"
38'-8"

BLOCK 2-2
BLOCK 2-3

PROPERTY BOUNDARY N:1920969.85 E: 7064613.97

EXISTING UNPAVED ROAD TO REMAIN

20' R.O.W.

PROPERTY BOUNDARY N:1920662.67 E: 7065018.49

PROPERTY BOUNDARY N:1920851.27 E: 7063735.00

APN# 0630-361-04 (VACANT)

APN# 0630-361-03 (VACANT)

PROPERTY BOUNDARY N:1920686.17 E: 7063736.26

APN# 0630-281-54 (VACANT)

15'

SESPE STREET

40' R.O.W.

APN# 0630-361-02 (VACANT)

APN# 0630-361-01 (VACANT)

66'-3"
41'-10"

PROPERTY BOUNDARY N:1920547.94 E: 7064617.10

EXISTING UNPAVED ROAD TO REMAIN

PROPERTY BOUNDARY N:1920642.40 E: 7064998.62

APN# 0630-361-13 (VACANT)
APN# 0630-361-14 (VACANT)

SUMMERS ROAD

APN# 0630-361-05 (VACANT)
APN# 0630-361-12 (VACANT)

GENERAL NOTES:

1. DRAWING BASED ON BONADAMIN ALTA SURVEY DATED 03-19-14.

2. EXISTING AND PROPOSED GENERAL PLAN RL-RURAL LIVING.

3. CONTOUR INTERVAL = 2'.

4. BOWMAN TRAIL, HERDMANS RD., AND SUNNY VISTA RD. ARE IRREVOCABLE OFFERS OF DEDICATIONS FOR PUBLIC STREET AND UTILITY PURPOSES.

5. ALL LOTS IN THE PROPOSED PROJECT ARE VACANT.

6. LOT LINES FOR LOTS 49-63 TO BE VACATED IN PROPOSED LAND USE.

7. ALL WEATHER ACCESS WAY TO EXTEND ONLY TO THE SWITCHYARD. THE REMAINING SITE ACCESS LANES WILL BE SCARAFIRED AND COMPACTED TO 90% NATIVE.

8. PROPOSED GEN-TIE WILL BE TO THE 33KV EAST-WEST TRANSMISSION LINE SOUTH OF RECHE ROAD. ±2100'

9. LIVERY ROAD TO BE DISSOLVED IN NEW LAND USE PERMIT.

SOLAR SITE PLAN
SCALE: 1" = 100'-0"
100' 50' 0 100' 200'

NORTHERN ENERGY & POWER LLC

LOCAL JOB NUMBER: 106

PROJECT TITLE: BOWMAN SOLAR 3 MWAC SAN BERNARDINO COUNTY, CA

SHEET TITLE: CUP SINGLE AXIS TRACKER PV SITE PLAN

DRAWING NUMBER: C1101

REVISION: A

DOCUMENT SIZE: ARCH D (24X36)

CHAIN-LINK SECURITY FENCE END & CORNER DETAILS [1]
SCALE: 1'-0" = 20'-0"   C5100

Labels (Detail 1):
- CORNER ARM (OPTION)
- BARBED WIRE
- TENSION WIRE
- BRACE RAIL
- END & CORNER POST
- LINE POST
- TRUSS ROD
- CHAIN-LINK
- LINE POST
- TENSION WIRE, OPTIONAL SPECIFY WHEN REQUIRED.
- GRADE
- 8'-0"
- 3'-6"
- CONCRETE BASE SEE NOTE 1
- 3'-6"
- 3'-6"
- 3'
- 1' DIA
- 10' MAXIMUM
- 10" DIA
- 10' MAXIMUM
- 10" DIA

CHAIN-LINK SECURITY BRACE PANEL DETAILS [2]
SCALE: 1'-0" = 20'-0"   C5100

Labels (Detail 2):
- BARBED WIRE
- TENSION WIRE
- LINE POST
- BRACE RAIL, OPTIONAL. SPECIFY WHEN REQUIRED.
- BRACE POST
- BRACE RAIL
- LINE POST
- TRUSS ROD OPTIONAL FENCE SUPPLIER SHALL SPECIFY WHEN REQUIRED.
- TENSION WIRE, OPTIONAL FENCE SUPPLIER SHALL SPECIFY WHEN REQUIRED.
- TRUSS ROD
- GRADE
- CONCRETE BASE SEE NOTE 10
- 8'-0"
- 3'-6"
- 3'-6"
- 3'-6"
- 10" DIA
- 10' MAXIMUM
- 1' DIA
- 10' MAXIMUM
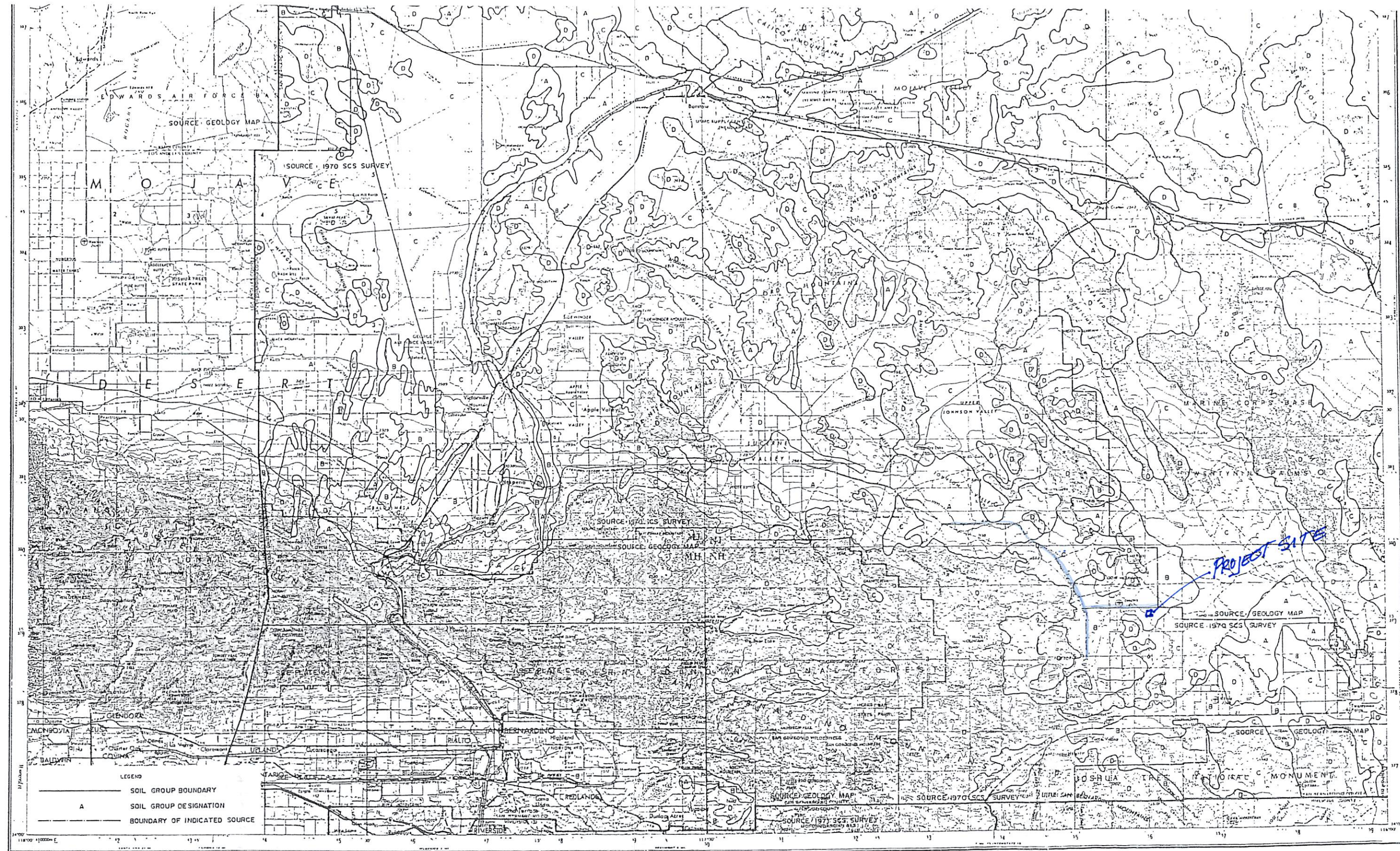- 10" DIA

NORTHERN ENERGY & POWER LLC

LOCAL JOB NUMBER: 106

PROJECT TITLE:
BOWMAN SOLAR
3 MWAC
SAN BERNARDINO
COUNTY, CA

SHEET TITLE:
CIVIL DETAILS

DRAWING NUMBER:
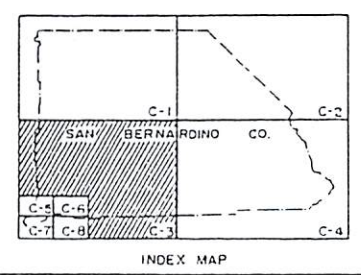C5100

REVISION: 1

DOCUMENT SIZE: ARCH D (24X36)

PLAN

DOUBLE SWING GATE DETAIL ①
SCALE: N.T.S.   C5101
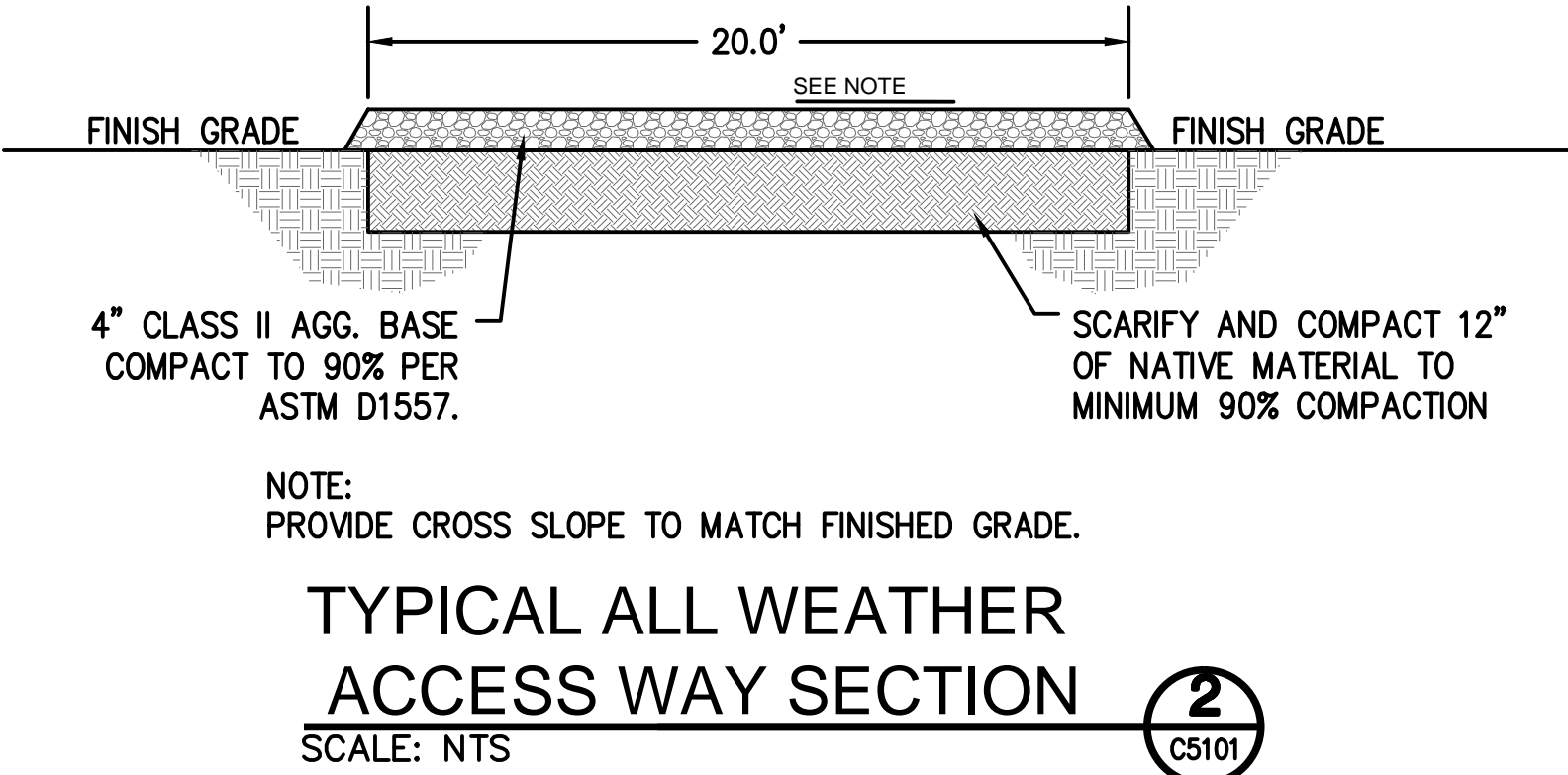
TYPICAL ALL WEATHER
ACCESS WAY SECTION ②
SCALE: NTS   C5101

NOTE:
PROVIDE CROSS SLOPE TO MATCH FINISHED GRADE.

4" CLASS II AGG. BASE COMPACT TO 90% PER ASTM D1557.

SCARIFY AND COMPACT 12" OF NATIVE MATERIAL TO MINIMUM 90% COMPACTION

20.0'   SEE NOTE

FINISH GRADE   FINISH GRADE

REV.	DATE	DESIGN	ENGINEER	APPROVE
A	4/24/14	DW	DW	KC

REVISION DESCRIPTION
ISSUED FOR C.U.P.

NORTHERN ENERGY & POWER LLC

LOCAL JOB NUMBER:
106

PROJECT TITLE:
BOWMAN SOLAR
3 MWAC
SAN BERNARDINO
COUNTY, CA

SHEET TITLE:
CIVIL DETAILS

DRAWING NUMBER:
C5101

REVISION: 1

DOCUMENT SIZE: ARCH D (24X36)

18'-6"

18'-6"

4'-3"

COMBINER
BOX

GRADE

36"

36"

LFNMC TO COMBINED ROW

DC FEEDER TO INVERTER
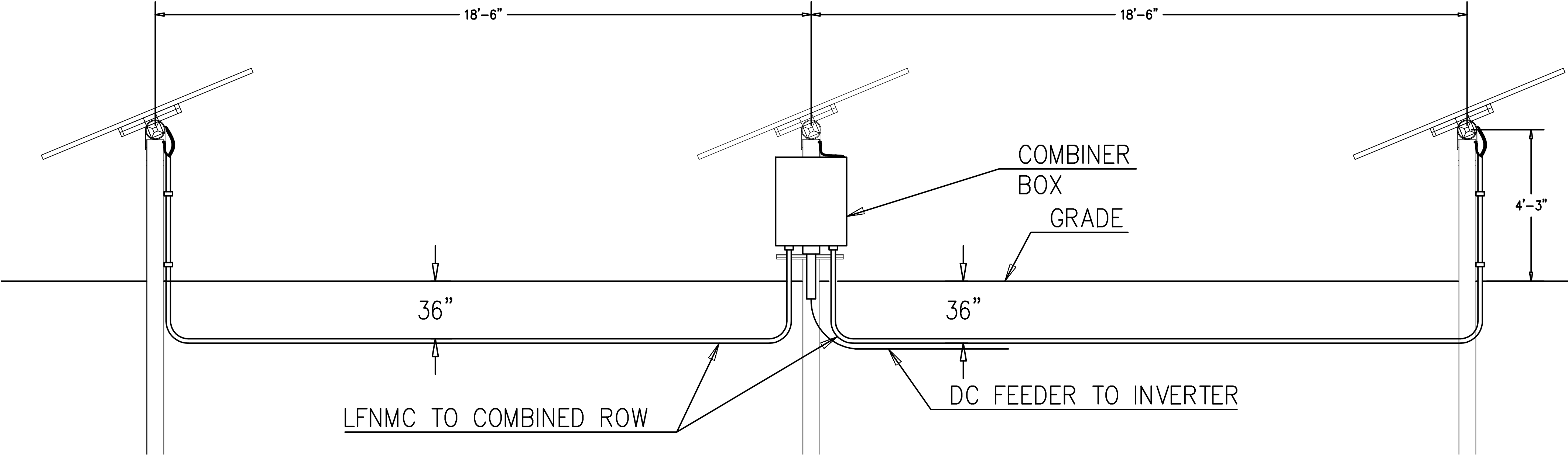
TRACKER FRONT VIEW
SCALE: NTS
1
C5102

COMBINER

GRADE

2'
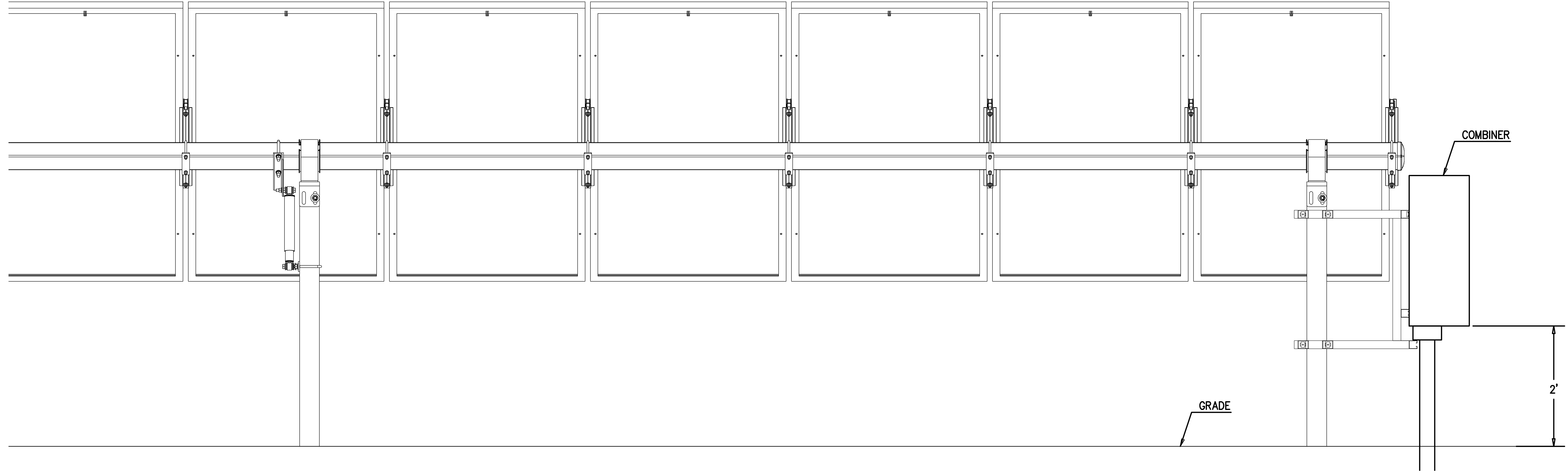
TRACKER SIDE VIEW
SCALE: N.T.S.
2
C5102

NORTHERN ENERGY
& POWER LLC

LOCAL JOB NUMBER:
106

PROJECT TITLE:
BOWMAN SOLAR
3 MWAC
SAN BERNARDINO
COUNTY, CA

SHEET TITLE:
SINGLE AXIS
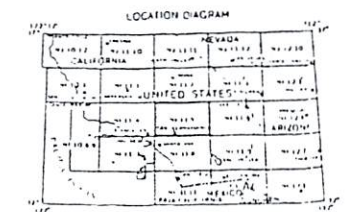TRACKER
DETAILS

DRAWING NUMBER:

C5102

REVISION:
A

DOCUMENT SIZE:
ARCH D (24X36)

Hydrologic Soils Group Map for Southcentral Area

Project Site — "Soils Group "B""

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

SCALE REDUCED BY 1/2

HYDROLOGIC SOILS GROUP MAP
FOR
SOUTHCENTRAL AREA ⑦

FIGURE C-11

Scale 1:250,000

CONTOUR INTERVAL 200 FEET
WITH SUPPLEMENTARY CONTOURS AT 100 FOOT INTERVALS
TRANSVERSE MERCATOR PROJECTION

BASE MAP REPRODUCED FROM U.S.G.S. "SAN BERNARDINO" TOPOGRAPHIC MAP

INDEX MAP

LOCATION DIAGRAM

LEGEND

————	SOIL GROUP BOUNDARY
A	SOIL GROUP DESIGNATION
———	BOUNDARY OF INDICATED SOURCE

C-24 *BOWMAN TRAIL*
LANDERS TR-11331

Figure ADD-1
Antecedent Moisture
Condition (AMC)

5-day Rainfall - NOAA Atlas 14
(50% of Total Rainfall Prior to Peak)*

*1/2 (11-day - 1-day) =
1/2 (([10-day] + (1/10 ([20-day] - [10-day]))) - [1-day])

Growing Season
AMC I
AMC II
AMC III

PROJECT SITE

LANDERS BOWMAN TRAIL

AMC 1

LANDERS

TWENTYNINE PALMS

MARINE CORPS

TRAINING

CENTER

R6E | R7E

T3N
T2N

T3N
T2N

R6E | R7E

See FI13 A

See FI14 A

RC

RC

RC

RC

RC

RC

HV/RC

HV/RL-5

HV/RL5

HV/RL

HV/RL-5

JT/RL-5

Goat Mountain (elev. 3,800)
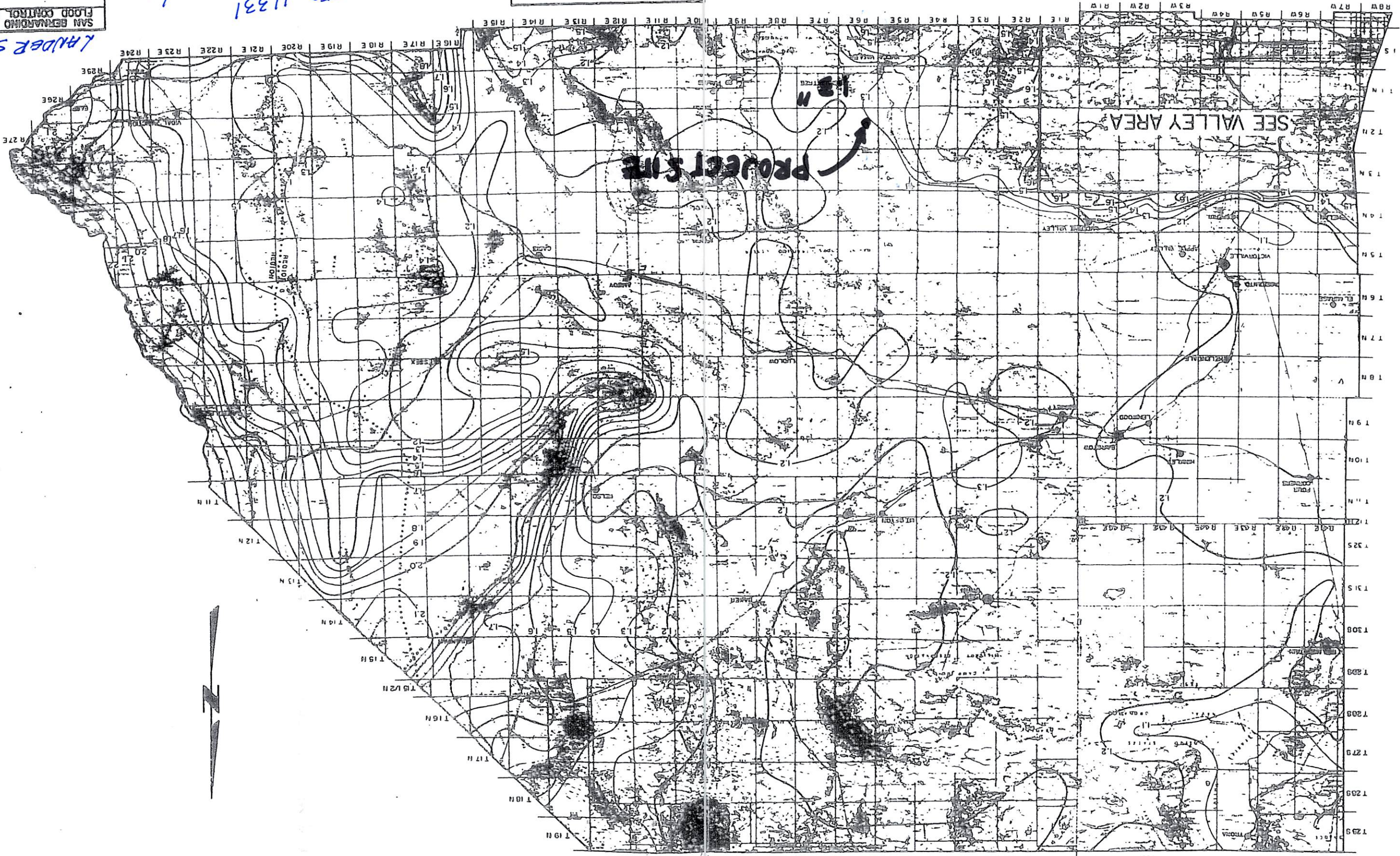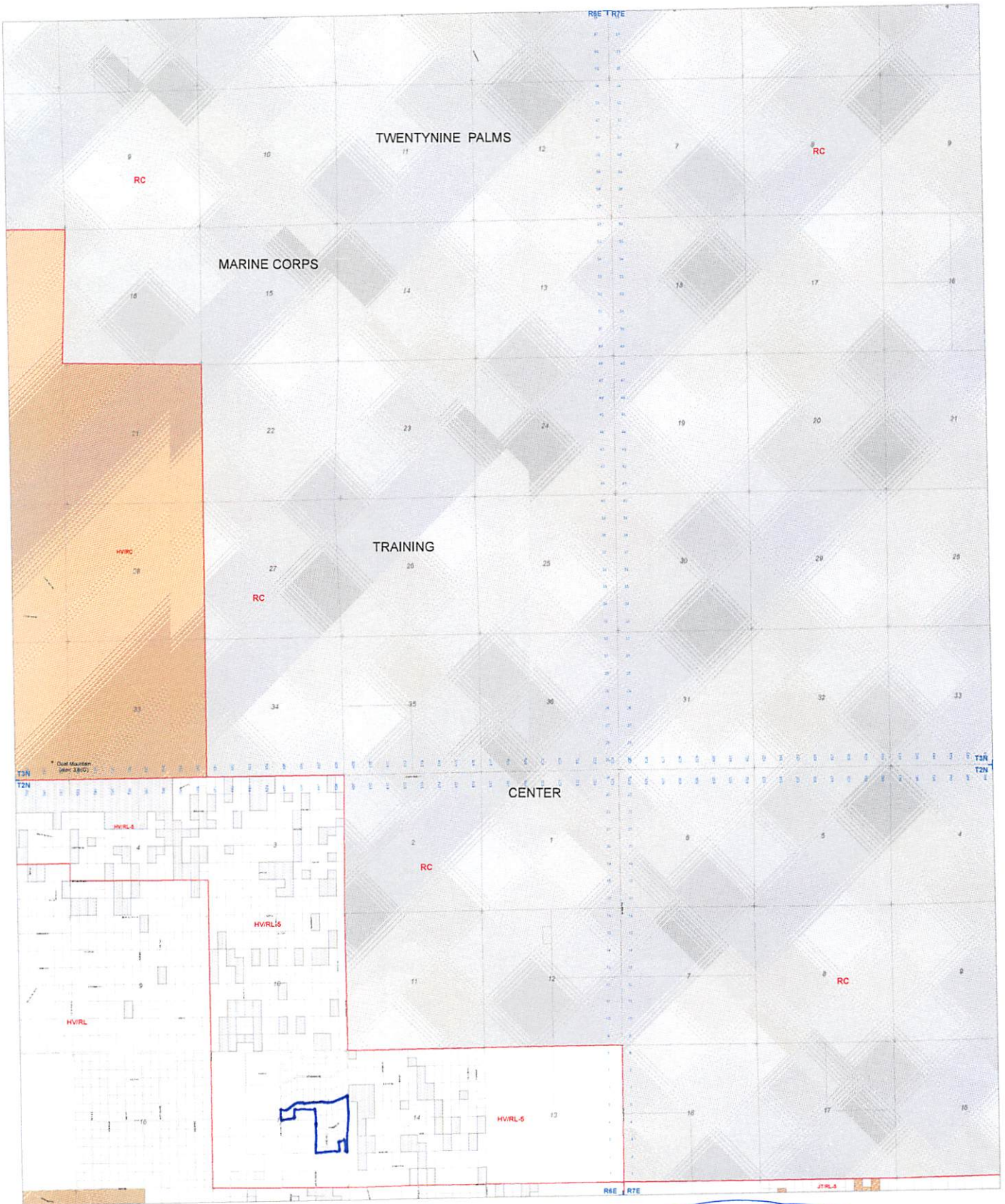
BOWMAN TRAIL
TR-11331

HV-RL-5

See FI22 A

San Bernardino County Land Use Plan
GENERAL PLAN
Land Use Zoning Districts

SCALE 1 14,400

FI14 A
Goat Mountain

9

Ludwig Engineering
109 E. 3rd Street
San Bernardino, California 92410
(909) 884-8217
FAX (909) 889-0153
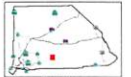
JOB   GL-0204
SHEET NO.____1_____ OF _____
CALCULATED BY___GAG_____ DATE __4-24-14___
CHECKED BY _____ DATE _____
SCALE _____

SUSTAINABLE POWER GROUP, LLC LANDERS (BOWMAN TRAIL) PRE-DEVELOPMENT

NODE NO.	AREA NO.	HIGH EL.(FT)	LOW EL.(FT)	LENGTH (FT)	AREA (AC)	SOIL TYPE	COVER TYPE	Q100 (CFS)	REMARKS
			FILE: BOWMANTRAILSLANDERSRAT.OUT						
1-2	1	3001	2975	950	10	B	UND. AVG COVER	15.9	**INITIAL SUBAREA**
2-3	2	2975	2924	1325	13.2	B	UND. AVG COVER	15.0	**IRR CHANNEL FLOW+ SUBAREA**
3-4	3	2924	2876	1893	18.3	B	UND. AVG COVER	12.3	**IRR CHANNEL FLOW+ SUBAREA**
3-4								43.2	**Confluence of minor streams 1 of 2**
5-6	4	2969	2930	1000	10	B	UND. AVG COVER	16.8	**INITIAL SUBAREA**
6-4	5	2930	2876	1720	1.4	B	UND. AVG COVER	0.0	**IRR CHANNEL FLOW+ SUBAREA**
6-4								61.0	**Confluence of minor streams 2 of 2**
4-7		2876	2867	460		B	UND. AVG COVER	61.0	**CHANNEL Travel Time only**
4-7								61.0	**Confluence of Main Streams 1 of 2**
1-8	6	3001	2981	1000	7.2	B	UND. AVG COVER	10.5	**INITIAL SUBAREA**
8-9	7	2981	2938	1147	19.9	B	UND. AVG COVER	23.0	**IRR CHANNEL FLOW+ SUBAREA**
9-10	8	2938	2898	1495	22.8	B	UND. AVG COVER	17.5	**IRR CHANNEL FLOW+ SUBAREA**
9-10								51.0	**Confluence of minor streams 1 of 2**
1-11	9	3001	2983	1000	6.0	B	UND. AVG COVER	8.6	**INITIAL SUBAREA**
11-12	10	2983	2936	1620	26.9	B	UND. AVG COVER	28.1	**IRR CHANNEL FLOW+ SUBAREA**
12-10	11	2936	2898	1485	23.2	B	UND. AVG COVER	15.5	**IRR CHANNEL FLOW+ SUBAREA**
12-10								104.1	**Confluence of minor streams 2 of 2**
10-7	12	2898	2867	1345	8.0	B	UND. AVG COVER	104.1	**IRR CHANNEL FLOW+ SUBAREA**
10-7								170.1	**Confluence of Main Streams 2 of 2**

100-YEAR, 1-HOUR STORM EVENT,OFFSITE DRAINAGE UNDEVELOPED
BOWMAN TRAIL, LANDERS
TRIBUTARY AREA 1 TO 12
FILE: BOWMANTRAILSLANDERSRAT.OUT

Program License Serial Number 4070

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

Rational hydrology study storm event year is   100.0
Computed rainfall intensity:
Storm year =   100.00   1 hour rainfall =   1.300 (In.)
Slope used for rainfall intensity curve b = 0.7000
Soil antecedent moisture condition (AMC) = 1

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      1.000 to Point/Station      2.000
                 **** INITIAL AREA EVALUATION ****
_____
         UNDEVELOPED (average cover) subarea
         Decimal fraction soil group A = 0.000
         Decimal fraction soil group B = 1.000
         Decimal fraction soil group C = 0.000
         Decimal fraction soil group D = 0.000
         SCS curve number for soil(AMC 2)  = 69.00
         Adjusted SCS curve number for AMC 1 = 49.80
         Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.812(In/Hr)
         Initial subarea data:
         Initial area flow distance =   950.000(Ft.)
         Top (of initial area) elevation =  3001.000(Ft.)
         Bottom (of initial area) elevation =  2975.000(Ft.)
         Difference in elevation =    26.000(Ft.)
         Slope =    0.02737  s(%)=       2.74
         TC = k(0.706)*[(length^3)/(elevation change)]^0.2
         Initial area time of concentration =   22.514 min.
         Rainfall intensity =     2.582(In/Hr) for a   100.0 year storm
         Effective runoff coefficient used for area (Q=KCIA) is C = 0.617
         Subarea runoff =      15.930(CFS)
         Total initial stream area =       10.000(Ac.)
         Pervious area fraction = 1.000
         Initial area Fm value =    0.812(In/Hr)
```

```
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      2.000 to Point/Station      3.000
            **** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
_____
    Estimated mean flow rate at midpoint of channel =     0.000(CFS)
    Depth of flow =   0.815(Ft.), Average velocity =   5.300(Ft/s)
        ******* Irregular Channel Data ***********
    -----------------------------------------------------------------
    Information entered for subchannel number 1 :
    Point number      'X' coordinate      'Y' coordinate
         1                0.00                1.50
         2               10.00                0.00
         3               20.00                1.50
    Manning's 'N' friction factor =   0.030
    -----------------------------------------------------------------
    Sub-Channel flow  =      23.451(CFS)
      '      '      flow top width =      10.862(Ft.)
      '      '       velocity=    5.300(Ft/s)
      '      '       area =        4.424(Sq.Ft)
      '      '      Froude number =      1.464

    Upstream point elevation =  2975.000(Ft.)
    Downstream point elevation =  2924.000(Ft.)
    Flow length =  1325.000(Ft.)
    Travel time  =     4.17 min.
    Time of concentration =    26.68 min.
    Depth of flow =   0.815(Ft.)
    Average velocity =    5.300(Ft/s)
    Total irregular channel flow =     23.451(CFS)
    Irregular channel normal depth above invert elev. =    0.815(Ft.)
    Average velocity of channel(s) =    5.300(Ft/s)
     Adding area flow to channel
    UNDEVELOPED (average cover) subarea
    Decimal fraction soil group A = 0.000
    Decimal fraction soil group B = 1.000
    Decimal fraction soil group C = 0.000
    Decimal fraction soil group D = 0.000
    SCS curve number for soil(AMC 2)  = 69.00
    Adjusted SCS curve number for AMC 1 = 49.80
    Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.812(In/Hr)
    Rainfall intensity =      2.293(In/Hr) for a   100.0 year storm
   Effective runoff coefficient used for area,(total area with modified
    rational method)(Q=KCIA) is C = 0.581
    Subarea runoff =      14.986(CFS) for   13.200(Ac.)
    Total runoff =       30.916(CFS)
    Effective area this stream =        23.20(Ac.)
    Total Study Area (Main Stream No. 1) =       23.20(Ac.)
    Area averaged Fm value =    0.812(In/Hr)
    Depth of flow =   0.904(Ft.), Average velocity =   5.680(Ft/s)
```

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       3.000 to Point/Station      4.000
            **** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
_____
     Estimated mean flow rate at midpoint of channel =     0.000(CFS)
     Depth of flow =   0.874(Ft.), Average velocity =   4.851(Ft/s)
          ******* Irregular Channel Data **********
     ----------------------------------------------------------------
     Information entered for subchannel number 1 :
     Point number       'X' coordinate       'Y' coordinate
          1               0.00                 1.50
          2              15.00                 0.00
          3              30.00                 1.50
     Manning's 'N' friction factor =   0.028
     ----------------------------------------------------------------
     Sub-Channel flow  =      37.076(CFS)
       '       '     flow top width =      17.484(Ft.)
       '       '      velocity=    4.851(Ft/s)
       '       '      area =       7.643(Sq.Ft)
       '       '      Froude number =      1.293

     Upstream point elevation =  2924.000(Ft.)
     Downstream point elevation =  2876.000(Ft.)
     Flow length =  1893.000(Ft.)
     Travel time  =     6.50 min.
     Time of concentration =    33.18 min.
     Depth of flow =   0.874(Ft.)
     Average velocity =   4.851(Ft/s)
     Total irregular channel flow =     37.076(CFS)
     Irregular channel normal depth above invert elev. =   0.874(Ft.)
     Average velocity of channel(s) =   4.851(Ft/s)
      Adding area flow to channel
     UNDEVELOPED (average cover) subarea
     Decimal fraction soil group A = 0.000
     Decimal fraction soil group B = 1.000
     Decimal fraction soil group C = 0.000
     Decimal fraction soil group D = 0.000
     SCS curve number for soil(AMC 2)  = 69.00
     Adjusted SCS curve number for AMC 1 = 49.80
     Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=      0.812(In/Hr)
     Rainfall intensity =       1.968(In/Hr) for a    100.0 year storm
    Effective runoff coefficient used for area,(total area with modified
     rational method)(Q=KCIA) is C = 0.529
     Subarea runoff =      12.261(CFS) for    18.300(Ac.)
     Total runoff =       43.176(CFS)
     Effective area this stream =         41.50(Ac.)
     Total Study Area (Main Stream No. 1) =        41.50(Ac.)
     Area averaged Fm value =     0.812(In/Hr)
     Depth of flow =   0.926(Ft.), Average velocity =   5.040(Ft/s)
```

```
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
 Process from Point/Station          3.000 to Point/Station         4.000
                   **** CONFLUENCE OF MAIN STREAMS ****
_____
       The following data inside Main Stream is listed:
       In Main Stream number: 1
       Stream flow area =      41.500(Ac.)
       Runoff from this stream =      43.176(CFS)
       Time of concentration =   33.18 min.
       Rainfall intensity =     1.968(In/Hr)
       Area averaged loss rate (Fm) =     0.8119(In/Hr)
       Area averaged Pervious ratio (Ap) = 1.0000
       Program is now starting with Main Stream No. 2
```

```
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
```
Process from Point/Station   5.000 to Point/Station   6.000
**** INITIAL AREA EVALUATION ****
_____

```
       UNDEVELOPED (average cover) subarea
       Decimal fraction soil group A = 0.000
       Decimal fraction soil group B = 1.000
       Decimal fraction soil group C = 0.000
       Decimal fraction soil group D = 0.000
       SCS curve number for soil(AMC 2)  = 69.00
       Adjusted SCS curve number for AMC 1 = 49.80
       Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.812(In/Hr)
       Initial subarea data:
       Initial area flow distance =  1000.000(Ft.)
       Top (of initial area) elevation =  2969.000(Ft.)
       Bottom (of initial area) elevation =  2930.000(Ft.)
       Difference in elevation =    39.000(Ft.)
       Slope =    0.03900  s(%)=       3.90
       TC = k(0.706)*[(length^3)/(elevation change)]^0.2
       Initial area time of concentration =   21.409 min.
       Rainfall intensity =      2.674(In/Hr) for a   100.0 year storm
       Effective runoff coefficient used for area (Q=KCIA) is C = 0.627
       Subarea runoff =      16.763(CFS)
       Total initial stream area =       10.000(Ac.)
       Pervious area fraction = 1.000
       Initial area Fm value =    0.812(In/Hr)
```

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      6.000 to Point/Station       4.000
              **** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
_____
     Estimated mean flow rate at midpoint of channel =      0.000(CFS)
     Depth of flow =   0.624(Ft.), Average velocity =   4.312(Ft/s)
          ******* Irregular Channel Data **********
     ------------------------------------------------------------------
     Information entered for subchannel number 1 :
     Point number      'X' coordinate      'Y' coordinate
          1               0.00               1.50
          2              15.00               0.00
          3              30.00               1.50
     Manning's 'N' friction factor =   0.028
     ------------------------------------------------------------------
     Sub-Channel flow  =      16.800(CFS)
        '      '     flow top width =      12.483(Ft.)
        '      '      velocity=    4.312(Ft/s)
        '      '      area =        3.896(Sq.Ft)
        '      '      Froude number =      1.360

     Upstream point elevation =  2930.000(Ft.)
     Downstream point elevation =  2876.000(Ft.)
     Flow length =  1720.000(Ft.)
     Travel time  =      6.65 min.
     Time of concentration =    28.06 min.
     Depth of flow =   0.624(Ft.)
     Average velocity =    4.312(Ft/s)
     Total irregular channel flow =      16.800(CFS)
     Irregular channel normal depth above invert elev. =    0.624(Ft.)
     Average velocity of channel(s) =    4.312(Ft/s)
      Adding area flow to channel
     UNDEVELOPED (average cover) subarea
     Decimal fraction soil group A = 0.000
     Decimal fraction soil group B = 1.000
     Decimal fraction soil group C = 0.000
     Decimal fraction soil group D = 0.000
     SCS curve number for soil(AMC 2)  = 69.00
     Adjusted SCS curve number for AMC 1 = 49.80
     Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=      0.812(In/Hr)
     The area added to the existing stream causes a
     a lower flow rate of Q =      14.377(CFS)
    therefore the upstream flow rate of Q =      16.763(CFS) is being used
     Rainfall intensity =      2.213(In/Hr) for a    100.0 year storm
    Effective runoff coefficient used for area,(total area with modified
     rational method)(Q=KCIA) is C = 0.570
     Subarea runoff =        0.000(CFS) for    1.400(Ac.)
     Total runoff =       16.763(CFS)
     Effective area this stream =         11.40(Ac.)
     Total Study Area (Main Stream No. 2) =        52.90(Ac.)
     Area averaged Fm value =     0.812(In/Hr)
```

Depth of flow =   0.624(Ft.), Average velocity =   4.310(Ft/s)

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       6.000 to Point/Station       4.000
                **** CONFLUENCE OF MAIN STREAMS ****
_____
        The following data inside Main Stream is listed:
        In Main Stream number: 2
        Stream flow area =      11.400(Ac.)
        Runoff from this stream =     16.763(CFS)
        Time of concentration =   28.06 min.
        Rainfall intensity =     2.213(In/Hr)
        Area averaged loss rate (Fm) =    0.8119(In/Hr)
        Area averaged Pervious ratio (Ap) = 1.0000
        Summary of stream data:

        Stream Flow rate    Area    TC      Fm       Rainfall Intensity
         No.    (CFS)   (Ac.)      (min) (In/Hr)     (In/Hr)


        1     43.18    41.500     33.18   0.812       1.968
        2     16.76    11.400     28.06   0.812       2.213
        Qmax(1) =
              1.000 *    1.000 *    43.176) +
              0.825 *    1.000 *    16.763) + =      57.005
        Qmax(2) =
              1.212 *    0.846 *    43.176) +
              1.000 *    1.000 *    16.763) + =      61.015


        Total of 2 main streams to confluence:
        Flow rates before confluence point:
            44.176      17.763
        Maximum flow rates at confluence using above data:
            57.005      61.015
        Area of streams before confluence:
            41.500      11.400
        Effective area values after confluence:
            52.900      46.488


        Results of confluence:
        Total flow rate =     61.015(CFS)
        Time of concentration =    28.057 min.
        Effective stream area after confluence  =     46.488(Ac.)
        Study area average Pervious fraction(Ap) =  1.000
        Study area average soil loss rate(Fm) =    0.812(In/Hr)
        Study area total =       52.90(Ac.)
```

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        4.000 to Point/Station        7.000
              **** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
_____
     Depth of flow =   1.106(Ft.), Average velocity =    4.986(Ft/s)
          ******* Irregular Channel Data ***********
     ----------------------------------------------------------------
     Information entered for subchannel number 1 :
     Point number      'X' coordinate      'Y' coordinate
          1               0.00               1.50
          2              15.00               0.00
          3              30.00               1.50
     Manning's 'N' friction factor =   0.028
     ----------------------------------------------------------------
     Sub-Channel flow  =      61.016(CFS)
       '     '    flow top width =      22.125(Ft.)
       '     '     velocity=    4.986(Ft/s)
       '     '    area =     12.238(Sq.Ft)
       '     '    Froude number =      1.181

     Upstream point elevation =  2876.000(Ft.)
     Downstream point elevation =  2867.000(Ft.)
     Flow length =    460.000(Ft.)
     Travel time  =     1.54 min.
     Time of concentration =    29.59 min.
     Depth of flow =   1.106(Ft.)
     Average velocity =    4.986(Ft/s)
     Total irregular channel flow =      61.015(CFS)
     Irregular channel normal depth above invert elev. =    1.106(Ft.)
     Average velocity of channel(s) =    4.986(Ft/s)
```

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
```
Process from Point/Station   4.000 to Point/Station   7.000
**** CONFLUENCE OF MAIN STREAMS ****

_____

```
        The following data inside Main Stream is listed:
        In Main Stream number: 1
        Stream flow area =      46.488(Ac.)
        Runoff from this stream =      61.015(CFS)
        Time of concentration =   29.59 min.
        Rainfall intensity =     2.132(In/Hr)
        Area averaged loss rate (Fm) =     0.8119(In/Hr)
        Area averaged Pervious ratio (Ap) = 1.0000
        Program is now starting with Main Stream No. 2
```

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
```
Process from Point/Station   1.000 to Point/Station   8.000
**** INITIAL AREA EVALUATION ****
_____
```
        UNDEVELOPED (average cover) subarea
        Decimal fraction soil group A = 0.000
        Decimal fraction soil group B = 1.000
        Decimal fraction soil group C = 0.000
        Decimal fraction soil group D = 0.000
        SCS curve number for soil(AMC 2)  = 69.00
        Adjusted SCS curve number for AMC 1 = 49.80
        Pervious ratio(Ap) = 1.0000    Max loss rate(Fm)=     0.812(In/Hr)
        Initial subarea data:
        Initial area flow distance =  1000.000(Ft.)
        Top (of initial area) elevation =  3001.000(Ft.)
        Bottom (of initial area) elevation =  2981.000(Ft.)
        Difference in elevation =    20.000(Ft.)
        Slope =    0.02000  s(%)=       2.00
        TC = k(0.706)*[(length^3)/(elevation change)]^0.2
        Initial area time of concentration =   24.468 min.
        Rainfall intensity =      2.436(In/Hr) for a   100.0 year storm
        Effective runoff coefficient used for area (Q=KCIA) is C = 0.600
        Subarea runoff =      10.522(CFS)
        Total initial stream area =         7.200(Ac.)
        Pervious area fraction = 1.000
        Initial area Fm value =    0.812(In/Hr)
```

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      8.000 to Point/Station      9.000
          **** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
_____
    Estimated mean flow rate at midpoint of channel =     0.000(CFS)
    Depth of flow =   0.686(Ft.), Average velocity =   4.684(Ft/s)
        ******* Irregular Channel Data ***********
    ----------------------------------------------------------------
    Information entered for subchannel number 1 :
    Point number      'X' coordinate      'Y' coordinate
        1                0.00                1.50
        2               15.00                0.00
        3               30.00                1.50
    Manning's 'N' friction factor =   0.030
    ----------------------------------------------------------------
    Sub-Channel flow  =     22.052(CFS)
      '      '     flow top width =      13.722(Ft.)
      '      '      velocity=    4.684(Ft/s)
      '      '      area =        4.707(Sq.Ft)
      '      '      Froude number =      1.409

    Upstream point elevation =  2981.000(Ft.)
    Downstream point elevation =  2938.000(Ft.)
    Flow length =  1147.000(Ft.)
    Travel time  =    4.08 min.
    Time of concentration =    28.55 min.
    Depth of flow =   0.686(Ft.)
    Average velocity =    4.684(Ft/s)
    Total irregular channel flow =     22.052(CFS)
    Irregular channel normal depth above invert elev. =   0.686(Ft.)
    Average velocity of channel(s) =    4.684(Ft/s)
     Adding area flow to channel
    UNDEVELOPED (average cover) subarea
    Decimal fraction soil group A = 0.000
    Decimal fraction soil group B = 1.000
    Decimal fraction soil group C = 0.000
    Decimal fraction soil group D = 0.000
    SCS curve number for soil(AMC 2)  = 69.00
    Adjusted SCS curve number for AMC 1 = 49.80
    Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.812(In/Hr)
    Rainfall intensity =      2.186(In/Hr) for a   100.0 year storm
   Effective runoff coefficient used for area,(total area with modified
    rational method)(Q=KCIA) is C = 0.566
    Subarea runoff =      23.002(CFS) for    19.900(Ac.)
    Total runoff =       33.525(CFS)
    Effective area this stream =         27.10(Ac.)
    Total Study Area (Main Stream No. 2) =        80.00(Ac.)
    Area averaged Fm value =     0.812(In/Hr)
    Depth of flow =   0.803(Ft.), Average velocity =   5.202(Ft/s)
```

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
```
Process from Point/Station   9.000 to Point/Station   10.000
               **** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
_____
```
     Estimated mean flow rate at midpoint of channel =     0.000(CFS)
     Depth of flow =   0.933(Ft.), Average velocity =   4.858(Ft/s)
          ******* Irregular Channel Data ***********
     ----------------------------------------------------------------
     Information entered for subchannel number 1 :
     Point number      'X' coordinate      'Y' coordinate
          1               0.00              1.50
          2              15.00              0.00
          3              30.00              1.50
     Manning's 'N' friction factor =   0.030
     ----------------------------------------------------------------
     Sub-Channel flow  =      42.314(CFS)
       '      '     flow top width =     18.665(Ft.)
       '      '      velocity=    4.858(Ft/s)
       '      '      area =        8.710(Sq.Ft)
       '      '      Froude number =      1.253

     Upstream point elevation =  2938.000(Ft.)
     Downstream point elevation =  2898.000(Ft.)
     Flow length =  1495.000(Ft.)
     Travel time  =     5.13 min.
     Time of concentration =   33.68 min.
     Depth of flow =   0.933(Ft.)
     Average velocity =   4.858(Ft/s)
     Total irregular channel flow =     42.314(CFS)
     Irregular channel normal depth above invert elev. =   0.933(Ft.)
     Average velocity of channel(s) =   4.858(Ft/s)
      Adding area flow to channel
     UNDEVELOPED (average cover) subarea
     Decimal fraction soil group A = 0.000
     Decimal fraction soil group B = 1.000
     Decimal fraction soil group C = 0.000
     Decimal fraction soil group D = 0.000
     SCS curve number for soil(AMC 2)  = 69.00
     Adjusted SCS curve number for AMC 1 = 49.80
     Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.812(In/Hr)
     Rainfall intensity =      1.948(In/Hr) for a   100.0 year storm
    Effective runoff coefficient used for area,(total area with modified
     rational method)(Q=KCIA) is C = 0.525
     Subarea runoff =      17.481(CFS) for   22.800(Ac.)
     Total runoff =      51.006(CFS)
     Effective area this stream =        49.90(Ac.)
     Total Study Area (Main Stream No. 2) =       102.80(Ac.)
     Area averaged Fm value =    0.812(In/Hr)
     Depth of flow =   1.001(Ft.), Average velocity =   5.091(Ft/s)
```

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
```
Process from Point/Station   9.000 to Point/Station   10.000
**** CONFLUENCE OF MINOR STREAMS ****
_____

        Along Main Stream number: 2 in normal stream number 1
        Stream flow area =   49.900(Ac.)
        Runoff from this stream =   51.006(CFS)
        Time of concentration =   33.68 min.
        Rainfall intensity =   1.948(In/Hr)
        Area averaged loss rate (Fm) =   0.8119(In/Hr)
        Area averaged Pervious ratio (Ap) = 1.0000

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        1.000 to Point/Station       11.000
                  **** INITIAL AREA EVALUATION ****
_____
        UNDEVELOPED (average cover) subarea
        Decimal fraction soil group A = 0.000
        Decimal fraction soil group B = 1.000
        Decimal fraction soil group C = 0.000
        Decimal fraction soil group D = 0.000
        SCS curve number for soil(AMC 2)  = 69.00
        Adjusted SCS curve number for AMC 1 = 49.80
        Pervious ratio(Ap) = 1.0000    Max loss rate(Fm)=    0.812(In/Hr)
        Initial subarea data:
        Initial area flow distance =  1000.000(Ft.)
        Top (of initial area) elevation =  3001.000(Ft.)
        Bottom (of initial area) elevation =  2983.000(Ft.)
        Difference in elevation =    18.000(Ft.)
        Slope =    0.01800  s(%)=       1.80
        TC = k(0.706)*[(length^3)/(elevation change)]^0.2
        Initial area time of concentration =   24.989 min.
        Rainfall intensity =      2.400(In/Hr) for a   100.0 year storm
        Effective runoff coefficient used for area (Q=KCIA) is C = 0.596
        Subarea runoff =       8.576(CFS)
        Total initial stream area =        6.000(Ac.)
        Pervious area fraction = 1.000
        Initial area Fm value =    0.812(In/Hr)
```

```
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      11.000 to Point/Station      12.000
              **** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
_____
    Estimated mean flow rate at midpoint of channel =     0.000(CFS)
    Depth of flow =   0.727(Ft.), Average velocity =   4.284(Ft/s)
         ******* Irregular Channel Data **********
    ----------------------------------------------------------------
    Information entered for subchannel number 1 :
    Point number      'X' coordinate      'Y' coordinate
         1                0.00                1.50
         2               15.00                0.00
         3               30.00                1.50
    Manning's 'N' friction factor =   0.030
    ----------------------------------------------------------------
    Sub-Channel flow  =      22.652(CFS)
      '      '     flow top width =      14.544(Ft.)
      '      '      velocity=    4.284(Ft/s)
      '      '      area =       5.288(Sq.Ft)
      '      '      Froude number =      1.252

    Upstream point elevation =  2983.000(Ft.)
    Downstream point elevation =  2936.000(Ft.)
    Flow length =  1620.000(Ft.)
    Travel time  =     6.30 min.
    Time of concentration =    31.29 min.
    Depth of flow =   0.727(Ft.)
    Average velocity =   4.284(Ft/s)
    Total irregular channel flow =     22.652(CFS)
    Irregular channel normal depth above invert elev. =   0.727(Ft.)
    Average velocity of channel(s) =   4.284(Ft/s)
     Adding area flow to channel
    UNDEVELOPED (average cover) subarea
    Decimal fraction soil group A = 0.000
    Decimal fraction soil group B = 1.000
    Decimal fraction soil group C = 0.000
    Decimal fraction soil group D = 0.000
    SCS curve number for soil(AMC 2)  = 69.00
    Adjusted SCS curve number for AMC 1 = 49.80
    Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.812(In/Hr)
    Rainfall intensity =      2.050(In/Hr) for a   100.0 year storm
   Effective runoff coefficient used for area,(total area with modified
    rational method)(Q=KCIA) is C = 0.544
    Subarea runoff =      28.097(CFS) for   26.900(Ac.)
    Total runoff =       36.673(CFS)
    Effective area this stream =        32.90(Ac.)
    Total Study Area (Main Stream No. 2) =       135.70(Ac.)
    Area averaged Fm value =     0.812(In/Hr)
    Depth of flow =   0.871(Ft.), Average velocity =   4.832(Ft/s)
```

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      12.000 to Point/Station      10.000
             **** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
_____
     Estimated mean flow rate at midpoint of channel =      0.000(CFS)
     Depth of flow =   0.959(Ft.), Average velocity =   4.837(Ft/s)
          ******* Irregular Channel Data **********
     ----------------------------------------------------------------
     Information entered for subchannel number 1 :
     Point number      'X' coordinate      'Y' coordinate
          1              0.00              1.50
          2             15.00              0.00
          3             30.00              1.50
     Manning's 'N' friction factor =   0.030
     ----------------------------------------------------------------
     Sub-Channel flow  =      44.443(CFS)
       '      '    flow top width =      19.172(Ft.)
       '      '     velocity=    4.837(Ft/s)
       '      '     area =         9.189(Sq.Ft)
       '      '     Froude number =      1.231

     Upstream point elevation =  2936.000(Ft.)
     Downstream point elevation =  2898.000(Ft.)
     Flow length =  1485.000(Ft.)
     Travel time  =     5.12 min.
     Time of concentration =   36.41 min.
     Depth of flow =   0.959(Ft.)
     Average velocity =   4.837(Ft/s)
     Total irregular channel flow =     44.443(CFS)
     Irregular channel normal depth above invert elev. =   0.959(Ft.)
     Average velocity of channel(s) =   4.837(Ft/s)
      Adding area flow to channel
     UNDEVELOPED (average cover) subarea
     Decimal fraction soil group A = 0.000
     Decimal fraction soil group B = 1.000
     Decimal fraction soil group C = 0.000
     Decimal fraction soil group D = 0.000
     SCS curve number for soil(AMC 2)  = 69.00
     Adjusted SCS curve number for AMC 1 = 49.80
     Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.812(In/Hr)
     Rainfall intensity =       1.844(In/Hr) for a   100.0 year storm
    Effective runoff coefficient used for area,(total area with modified
     rational method)(Q=KCIA) is C = 0.504
     Subarea runoff =      15.446(CFS) for   23.200(Ac.)
     Total runoff =       52.119(CFS)
     Effective area this stream =        56.10(Ac.)
     Total Study Area (Main Stream No. 2) =       158.90(Ac.)
     Area averaged Fm value =    0.812(In/Hr)
     Depth of flow =   1.018(Ft.), Average velocity =   5.033(Ft/s)
```

                **** CONFLUENCE OF MINOR STREAMS ****
_____

      Along Main Stream number: 2 in normal stream number 2
      Stream flow area =   56.100(Ac.)
      Runoff from this stream =   52.119(CFS)
      Time of concentration =   36.41 min.
      Rainfall intensity =   1.844(In/Hr)
      Area averaged loss rate (Fm) =   0.8119(In/Hr)
      Area averaged Pervious ratio (Ap) = 1.0000
      Summary of stream data:

      Stream Flow rate   Area   TC   Fm   Rainfall Intensity
       No.   (CFS)   (Ac.)   (min) (In/Hr)   (In/Hr)

      1   51.01   49.900   33.68   0.812   1.948
      2   52.12   56.100   36.41   0.812   1.844
      Qmax(1) =
            1.000 *   1.000 *   51.006) +
            1.100 *   0.925 *   52.119) + =   104.047
      Qmax(2) =
            0.909 *   1.000 *   51.006) +
            1.000 *   1.000 *   52.119) + =   98.478

      Total of 2 streams to confluence:
      Flow rates before confluence point:
           51.006   52.119
      Maximum flow rates at confluence using above data:
           104.047   98.478
      Area of streams before confluence:
            49.900   56.100
      Effective area values after confluence:
           101.791   106.000
      Results of confluence:
      Total flow rate =   104.047(CFS)
      Time of concentration =   33.678 min.
      Effective stream area after confluence =   101.791(Ac.)
      Study area average Pervious fraction(Ap) = 1.000
      Study area average soil loss rate(Fm) =   0.812(In/Hr)
      Study area total (this main stream) =   106.00(Ac.)

```
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      10.000 to Point/Station      7.000
             **** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
_____
    Estimated mean flow rate at midpoint of channel =      0.000(CFS)
    Depth of flow =   1.345(Ft.), Average velocity =   5.753(Ft/s)
         ******* Irregular Channel Data **********
    ----------------------------------------------------------------
    Information entered for subchannel number 1 :
    Point number      'X' coordinate      'Y' coordinate
         1              0.00               1.50
         2             15.00               0.00
         3             30.00               1.50
    Manning's 'N' friction factor =   0.030
    ----------------------------------------------------------------
    Sub-Channel flow  =     104.079(CFS)
      '      '    flow top width =      26.900(Ft.)
      '      '     velocity=    5.753(Ft/s)
      '      '     area =      18.091(Sq.Ft)
      '      '     Froude number =      1.236

    Upstream point elevation =  2898.000(Ft.)
    Downstream point elevation =  2867.000(Ft.)
    Flow length =  1345.000(Ft.)
    Travel time  =     3.90 min.
    Time of concentration =    37.57 min.
    Depth of flow =   1.345(Ft.)
    Average velocity =   5.753(Ft/s)
    Total irregular channel flow =   104.079(CFS)
    Irregular channel normal depth above invert elev. =   1.345(Ft.)
    Average velocity of channel(s) =   5.753(Ft/s)
     Adding area flow to channel
    UNDEVELOPED (average cover) subarea
    Decimal fraction soil group A = 0.000
    Decimal fraction soil group B = 1.000
    Decimal fraction soil group C = 0.000
    Decimal fraction soil group D = 0.000
    SCS curve number for soil(AMC 2)  = 69.00
    Adjusted SCS curve number for AMC 1 = 49.80
    Pervious ratio(Ap) = 1.0000    Max loss rate(Fm)=      0.812(In/Hr)
    The area added to the existing stream causes a
    a lower flow rate of Q =      98.027(CFS)
  therefore the upstream flow rate of Q =     104.047(CFS) is being used
    Rainfall intensity =       1.804(In/Hr) for a    100.0 year storm
   Effective runoff coefficient used for area,(total area with modified
    rational method)(Q=KCIA) is C = 0.495
    Subarea runoff =        0.000(CFS) for     8.000(Ac.)
    Total runoff =     104.047(CFS)
    Effective area this stream =        109.79(Ac.)
    Total Study Area (Main Stream No. 2) =        166.90(Ac.)
    Area averaged Fm value =     0.812(In/Hr)
```

```
       Depth of flow =    1.345(Ft.), Average velocity =    5.753(Ft/s)
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        10.000 to Point/Station        7.000
                 **** CONFLUENCE OF MAIN STREAMS ****
_____
     The following data inside Main Stream is listed:
     In Main Stream number: 2
     Stream flow area =    109.791(Ac.)
     Runoff from this stream =    104.047(CFS)
     Time of concentration =   37.57 min.
     Rainfall intensity =     1.804(In/Hr)
     Area averaged loss rate (Fm) =    0.8119(In/Hr)
     Area averaged Pervious ratio (Ap) = 1.0000
     Summary of stream data:

     Stream Flow rate    Area    TC      Fm       Rainfall Intensity
      No.    (CFS)    (Ac.)      (min) (In/Hr)      (In/Hr)


     1     61.02    46.488     29.59    0.812       2.132
     2    104.05   109.791     37.57    0.812       1.804
     Qmax(1) =
            1.000 *    1.000 *    61.015) +
            1.331 *    0.788 *   104.047) + =      170.070
     Qmax(2) =
            0.751 *    1.000 *    61.015) +
            1.000 *    1.000 *   104.047) + =      149.897


     Total of 2 main streams to confluence:
     Flow rates before confluence point:
           62.015     105.047
     Maximum flow rates at confluence using above data:
          170.070     149.897
     Area of streams before confluence:
           46.488     109.791
     Effective area values after confluence:
          132.963     156.280


     Results of confluence:
     Total flow rate =    170.070(CFS)
     Time of concentration =    29.594 min.
     Effective stream area after confluence  =    132.963(Ac.)
     Study area average Pervious fraction(Ap) =  1.000
     Study area average soil loss rate(Fm) =    0.812(In/Hr)
     Study area total =    156.28(Ac.)
     End of computations, Total Study Area =        166.90 (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) = 1.000
     Area averaged SCS curve number =  69.0
```

POST-DEVLOPMENT
SUSTAINABLE POWER GROUP, LLC LANDERS (BOWMAN TRAIL) POST-DEVELOPMENT

NODE NO.	AREA NO.	HIGH EL.(FT)	LOW EL.(FT)	LENGTH (FT)	AREA (AC)	SOIL TYPE	COVER TYPE	Q100 (CFS)	REMARKS
				FILE: POSTDEVBOWMAN.OUT					
1-2	1	2969	2930	1000	10	B	UND. AVG COVER	22.7	**INITIAL SUBAREA**
2-3	2	2930	2867	1720	8.3	B	UND. AVG COVER	8.6	**IRR CHANNEL FLOW+ SUBAREA**
2-3								31.3	**Confluence of Main streams 1 of 3**
4-4	offsite							30.9	**User specified info at point, offsite runoff**
4-3	3	2924	2867	1600	9.3	B	UND. AVG COVER	4.1	**IRR CHANNEL FLOW+ SUBAREA**
4-3								35	**Confluence of Main streams 2 of 3**
5-5	offsite							104.1	**User specified info at point, offsite runoff**
5-3	4	2898	2867	800	8.1	B	UND. AVG COVER	11.2	**IRR CHANNEL FLOW+ SUBAREA**
5-3								189.5	**Confluence of Main Streams 3 of 3**

CIVILCADD/CIVILDESIGN Engineering Software, (c) 1989-2005 Version 7.1
         Rational Hydrology Study   Date: 05/02/14
----
100 -YEAR, 1-HOUR STORM EVENT, ONSITE DRAINAGE POST-DEVELOPMENT
                BOWMAN TRAIL, LANDERS, CA
                 TRIBUTARY AREAS 1 TO 4
                FILE: POSTDEVBOWMAN.OUT

       Program License Serial Number 4070

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

     Rational hydrology study storm event year is   100.0
     Computed rainfall intensity:
     Storm year =   100.00   1 hour rainfall =   1.300 (In.)
     Slope used for rainfall intensity curve b = 0.7000
     Soil antecedent moisture condition (AMC) = 1

Ludwig Engineering
109 E. Third St.
San Bernardino, CA 92410
Ph. 909-884-8217   Fax 909-889-0153

JOB _____
SHEET NO. _____ OF _____
CALCULATED BY_____ DATE _____
CHECKED BY_____ DATE _____
SCALE _____

CALCULATE EFFECTIVE AREA @ OFFSITE
RUNOFF NODE ④

$$Q = 0.9(I - F_m)A_c$$

$$\therefore A_c = [Q / 0.9(I - F_m)]$$

$$A_c = \frac{30.9}{0.9(2.29 - 0.812)} = 23.2 \ Ac$$

$T_c = 26.68$ min.

$Q = 30.9$ cfs
$F_m = 0.812$ in/hr
$I = 2.29$ in/hr

CALCULATE EFFECTIVE AREA @ OFFSITE
RUNOFF NODE ⑤

$$Q = 0.9(I - F_m)A_c$$

$T_c = 33.68$ min
$Q_{100} = 104.1$ cfs
$F_m = 0.812$ in/hr
$I = 1.844$ in/hr

$$A_c = \frac{104.1}{0.9(1.844 - 0.812)} = 112.1 \ Ac$$

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
```
Process from Point/Station   1.000 to Point/Station   2.000
**   **** INITIAL AREA EVALUATION ******
_____

       Soil classification AP and SCS values input by user
       USER INPUT of soil data for subarea
       SCS curve number for soil(AMC 2) = 25.00
       Adjusted SCS curve number for AMC 1 = 12.00
       Pervious ratio(Ap) = 0.9000   Max loss rate(Fm)=   0.900(In/Hr)
       Initial subarea data:
       Initial area flow distance = 1000.000(Ft.)
       Top (of initial area) elevation = 2969.000(Ft.)
       Bottom (of initial area) elevation = 2930.000(Ft.)
       Difference in elevation =   39.000(Ft.)
       Slope =   0.03900 s(%)=   3.90
       TC = k(0.496)*[(length^3)/(elevation change)]^0.2
       Initial area time of concentration =   15.054 min.
       Rainfall intensity =   3.422(In/Hr) for a   100.0 year storm
       Effective runoff coefficient used for area (Q=KCIA) is C = 0.663
       Subarea runoff =   22.699(CFS)
       Total initial stream area =   10.000(Ac.)
       Pervious area fraction = 0.900
       Initial area Fm value =   0.900(In/Hr)

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
   Process from Point/Station       2.000 to Point/Station       3.000
             **** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
_____
     Estimated mean flow rate at midpoint of channel =     0.000(CFS)
     Depth of flow =   0.634(Ft.), Average velocity =   5.773(Ft/s)
          ******* Irregular Channel Data ***********
     ----------------------------------------------------------------
     Information entered for subchannel number 1 :
     Point number      'X' coordinate      'Y' coordinate
          1                0.00               0.90
          2               20.00               0.50
          3               30.00               0.00
          4               32.00               1.00
     Manning's 'N' friction factor =   0.020
     ----------------------------------------------------------------
     Sub-Channel flow  =      27.066(CFS)
       '    '     flow top width =     17.961(Ft.)
       '    '      velocity=    5.773(Ft/s)
       '    '      area =       4.688(Sq.Ft)
       '    '      Froude number =      1.991

     Upstream point elevation =  2930.000(Ft.)
     Downstream point elevation =  2867.000(Ft.)
     Flow length =  1720.000(Ft.)
     Travel time  =     4.97 min.
     Time of concentration =   20.02 min.
     Depth of flow =   0.634(Ft.)
     Average velocity =   5.773(Ft/s)
     Total irregular channel flow =     27.066(CFS)
     Irregular channel normal depth above invert elev. =   0.634(Ft.)
     Average velocity of channel(s) =   5.773(Ft/s)
      Adding area flow to channel
     Soil classification AP and SCS  values input by user
     USER INPUT of soil data for subarea
     SCS curve number for soil(AMC 2)  = 25.00
     Adjusted SCS curve number for AMC 1 = 12.00
     Pervious ratio(Ap) = 0.9000     Max loss rate(Fm)=     0.900(In/Hr)
     Rainfall intensity =     2.803(In/Hr) for a   100.0 year storm
    Effective runoff coefficient used for area,(total area with modified
     rational method)(Q=KCIA) is C = 0.611
     Subarea runoff =       8.644(CFS) for     8.300(Ac.)
     Total runoff =      31.343(CFS)
     Effective area this stream =        18.30(Ac.)
     Total Study Area (Main Stream No. 1) =       18.30(Ac.)
     Area averaged Fm value =    0.900(In/Hr)
     Depth of flow =   0.667(Ft.), Average velocity =   5.903(Ft/s)
```

```
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
   Process from Point/Station        2.000 to Point/Station        3.000
                  **** CONFLUENCE OF MAIN STREAMS ****
_____
        The following data inside Main Stream is listed:
        In Main Stream number: 1
        Stream flow area =       18.300(Ac.)
        Runoff from this stream =      31.343(CFS)
        Time of concentration =   20.02 min.
        Rainfall intensity =      2.803(In/Hr)
        Area averaged loss rate (Fm) =    0.9000(In/Hr)
        Area averaged Pervious ratio (Ap) = 0.9000
        Program is now starting with Main Stream No. 2
```

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
   Process from Point/Station       4.100 to Point/Station       4.000
          **** USER DEFINED FLOW INFORMATION AT A POINT ****
_____
       UNDEVELOPED (average cover) subarea
       Decimal fraction soil group A = 0.000
       Decimal fraction soil group B = 1.000
       Decimal fraction soil group C = 0.000
       Decimal fraction soil group D = 0.000
       SCS curve number for soil(AMC 2)  = 69.00
       Adjusted SCS curve number for AMC 1 = 49.80
       Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.812(In/Hr)
       Rainfall intensity =     2.293(In/Hr) for a   100.0 year storm
       User specified values are as follows:
       TC =  26.68 min.  Rain intensity =       2.29(In/Hr)
       Total area this stream =        23.20(Ac.)
       Total Study Area (Main Stream No. 2) =       41.50(Ac.)
       Total runoff =     30.90(CFS)
```

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
   Process from Point/Station       4.000 to Point/Station       3.000
            **** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
_____
    Estimated mean flow rate at midpoint of channel =     0.000(CFS)
    Depth of flow =   0.785(Ft.), Average velocity =   5.352(Ft/s)
         ******* Irregular Channel Data ***********
    ----------------------------------------------------------------
    Information entered for subchannel number 1 :
    Point number       'X' coordinate       'Y' coordinate
         1               0.00                 1.50
         2              15.00                 0.00
         3              30.00                 1.50
    Manning's 'N' friction factor =   0.028
    ----------------------------------------------------------------
    Sub-Channel flow  =      32.986(CFS)
      '      '    flow top width =      15.701(Ft.)
      '      '     velocity=    5.352(Ft/s)
      '      '    area =       6.163(Sq.Ft)
      '      '    Froude number =     1.506

    Upstream point elevation =  2924.000(Ft.)
    Downstream point elevation =  2867.000(Ft.)
    Flow length =  1600.000(Ft.)
    Travel time  =    4.98 min.
    Time of concentration =   31.66 min.
    Depth of flow =   0.785(Ft.)
    Average velocity =   5.352(Ft/s)
    Total irregular channel flow =     32.986(CFS)
    Irregular channel normal depth above invert elev. =   0.785(Ft.)
    Average velocity of channel(s) =   5.352(Ft/s)
     Adding area flow to channel
    Soil classification AP and SCS  values input by user
    USER INPUT of soil data for subarea
    SCS curve number for soil(AMC 2)  = 25.00
    Adjusted SCS curve number for AMC 1 = 12.00
    Pervious ratio(Ap) = 0.9000     Max loss rate(Fm)=     0.900(In/Hr)
    Rainfall intensity =      2.034(In/Hr) for a   100.0 year storm
   Effective runoff coefficient used for area,(total area with modified
    rational method)(Q=KCIA) is C = 0.530
    Subarea runoff =      4.098(CFS) for     9.300(Ac.)
    Total runoff =      34.998(CFS)
    Effective area this stream =        32.50(Ac.)
    Total Study Area (Main Stream No. 2) =        50.80(Ac.)
    Area averaged Fm value =    0.837(In/Hr)
    Depth of flow =   0.803(Ft.), Average velocity =   5.432(Ft/s)
```

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
   Process from Point/Station        4.000 to Point/Station        3.000
                    **** CONFLUENCE OF MAIN STREAMS ****
_____
        The following data inside Main Stream is listed:
        In Main Stream number: 2
        Stream flow area =      32.500(Ac.)
        Runoff from this stream =      34.998(CFS)
        Time of concentration =   31.66 min.
        Rainfall intensity =     2.034(In/Hr)
        Area averaged loss rate (Fm) =     0.8371(In/Hr)
        Area averaged Pervious ratio (Ap) = 0.9714
        Program is now starting with Main Stream No. 3
```

```
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
  Process from Point/Station        5.100 to Point/Station       5.000
          **** USER DEFINED FLOW INFORMATION AT A POINT ****
_____
        UNDEVELOPED (average cover) subarea
        Decimal fraction soil group A = 0.000
        Decimal fraction soil group B = 1.000
        Decimal fraction soil group C = 0.000
        Decimal fraction soil group D = 0.000
        SCS curve number for soil(AMC 2)  = 69.00
        Adjusted SCS curve number for AMC 1 = 49.80
        Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.812(In/Hr)
        Rainfall intensity =      1.948(In/Hr) for a   100.0 year storm
        User specified values are as follows:
        TC =  33.68 min.  Rain intensity =        1.95(In/Hr)
        Total area this stream =        112.10(Ac.)
        Total Study Area (Main Stream No. 3) =      162.90(Ac.)
        Total runoff =    104.10(CFS)
```

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
   Process from Point/Station      5.000 to Point/Station      3.000
            **** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
_____
     Estimated mean flow rate at midpoint of channel =      0.000(CFS)
     Depth of flow =   0.967(Ft.), Average velocity =   8.168(Ft/s)
          ******* Irregular Channel Data ***********
     ----------------------------------------------------------------
     Information entered for subchannel number 1 :
     Point number      'X' coordinate      'Y' coordinate
          1                0.00                1.00
          2                2.00                0.00
          3               12.00                0.50
          4               32.00                0.90
     Manning's 'N' friction factor =   0.020
     ----------------------------------------------------------------
     Sub-Channel flow  =     109.692(CFS)
       '     '      flow top width =     31.933(Ft.)
       '     '       velocity=     8.168(Ft/s)
       '     '       area =     13.429(Sq.Ft)
       '     '       Froude number =     2.220

     Upstream point elevation =  2898.000(Ft.)
     Downstream point elevation =  2867.000(Ft.)
     Flow length =   800.000(Ft.)
     Travel time  =     1.63 min.
     Time of concentration =   35.31 min.
     Depth of flow =   0.967(Ft.)
     Average velocity =   8.168(Ft/s)
     Total irregular channel flow =   109.692(CFS)
     Irregular channel normal depth above invert elev. =   0.967(Ft.)
     Average velocity of channel(s) =   8.168(Ft/s)
      Adding area flow to channel
     Soil classification AP and SCS  values input by user
     USER INPUT of soil data for subarea
     SCS curve number for soil(AMC 2)  = 25.00
     Adjusted SCS curve number for AMC 1 = 12.00
     Pervious ratio(Ap) = 0.9000     Max loss rate(Fm)=     0.900(In/Hr)
     Rainfall intensity =     1.884(In/Hr) for a   100.0 year storm
    Effective runoff coefficient used for area,(total area with modified
     rational method)(Q=KCIA) is C = 0.509
     Subarea runoff =     11.245(CFS) for    8.100(Ac.)
     Total runoff =    115.345(CFS)
     Effective area this stream =      120.20(Ac.)
     Total Study Area (Main Stream No. 3) =      171.00(Ac.)
     Area averaged Fm value =    0.818(In/Hr)
     Depth of flow =   0.980(Ft.), Average velocity =   8.331(Ft/s)
```

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
   Process from Point/Station        5.000 to Point/Station       3.000
                  **** CONFLUENCE OF MAIN STREAMS ****
_____
      The following data inside Main Stream is listed:
      In Main Stream number: 3
      Stream flow area =     120.200(Ac.)
      Runoff from this stream =    115.345(CFS)
      Time of concentration =    35.31 min.
      Rainfall intensity =      1.884(In/Hr)
      Area averaged loss rate (Fm) =     0.8178(In/Hr)
      Area averaged Pervious ratio (Ap) = 0.9933
      Summary of stream data:

      Stream Flow rate    Area     TC      Fm       Rainfall Intensity
       No.    (CFS)   (Ac.)       (min) (In/Hr)      (In/Hr)


      1    31.34    18.300     20.02    0.900      2.803
      2    35.00    32.500     31.66    0.837      2.034
      3   115.35   120.200     35.31    0.818      1.884
      Qmax(1) =
             1.000 *    1.000 *    31.343) +
             1.643 *    0.632 *    34.998) +
             1.862 *    0.567 *   115.345) + =     189.454
      Qmax(2) =
             0.596 *    1.000 *    31.343) +
             1.000 *    1.000 *    34.998) +
             1.140 *    0.897 *   115.345) + =     171.595
      Qmax(3) =
             0.517 *    1.000 *    31.343) +
             0.875 *    1.000 *    34.998) +
             1.000 *    1.000 *   115.345) + =     162.177

      Total of 3 main streams to confluence:
      Flow rates before confluence point:
           32.343       35.998      116.345
      Maximum flow rates at confluence using above data:
           189.454      171.595       162.177
      Area of streams before confluence:
            18.300        32.500      120.200
      Effective area values after confluence:
           106.995      158.575      171.000


      Results of confluence:
      Total flow rate =     189.454(CFS)
      Time of concentration =    20.020 min.
      Effective stream area after confluence  =    106.995(Ac.)
      Study area average Pervious fraction(Ap) =  0.979
      Study area average soil loss rate(Fm) =    0.830(In/Hr)
```

```
Study area total =      171.00(Ac.)
End of computations, Total Study Area =         171.00 (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) = 0.979
Area averaged SCS curve number =  59.8
```

DRAINAGE MAP
OFFSITE PREDEVELOPED
TRACT No. 11331
APRIL 24,2014

Prepared by:

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SCALE 1" = 300'

LEGEND

INDICATES TRACT BOUNDARY
INDICATES WATERSHED BOUNDARY
INDICATES SUB-AREA BOUNDARY
INDICATES SUB-AREA RUN-OFF TRAVEL LENGTH

[1] INDICATES SUB-AREA
    INDICATES SUB-AREA ACREAGE
    INDICATES SUB-AREA BOUNDARY

3340 INDICATES NODE ELEVATION

INDICATES CONCENTRATED STORM RUNOFF

INDICATES SHEET FLOW STORM RUNOFF

PREDEVELOPED
Q100=1701 CFS
FLOW TOWARDS EXISTING NORTHEAST
FLOWLINE

BOUNDARY

AREA 1
10 AC.
950LF.

AREA 2
13.2 AC.
1325LF.

AREA 3
18.3 AC.
1893LF.

AREA 4
10 AC.
1000LF.

AREA 5
1.4 AC.
1720 LF.

AREA 6
7.2 AC.
1000LF.

AREA 7
19.9 AC.
1147LF.

AREA 8
22.8 AC.
1495LF.

AREA 9
6 AC.
1000LF.

AREA 10
26.9 AC.
1620 LF.

AREA 11
23.2 AC.
1485LF.

AREA 12
8.0 AC.
1345LF.

Q100=16.8CFS
Q100=15.9CFS
Q100=8.6CFS
Q100=10.5CFS
Q100=16.8CFS
Q100=30.9CFS
Q100=37.5CFS
Q100=36.7CFS
Q100=51CFS
Q100=52.1CFS

3001'
3001'
2975'
2969'
2983'
2981'
2938'
2924'
2936'
2898'
2876'
2867'
460'
2946

W:\plans\Global Renewable Energy LLC\Hydrology Bowman Trail Landers\TAR Final Map Bowman_5-2-2014\SHEETS\OFFSite.dwg

AREA 2
8.3 AC.
1720LF.

POST DEVELOPED
Q100=189.1 CFS
FLOW TOWARDS EXISTING N
FLOWLINE

3

2867'

2

Q100=31.3CFS

Q100=22.7CFS

PROPERTY
BOUNDARY

Q100=115.3CFS

Q100=35CFS

AREA 1
10 AC.
1000LF.

15
2969

1

OFFSITE DRAINAGE
Q100=30.9CFS

4

2924

5

PROPERTY
BOUNDARY

AREA 3
9.3 AC.
1600LF.

PROPERTY
BOUNDARY

OFFISTE DRAINAGE
Q100=104.1CFS

AREA 4
8.1 AC.
800LF.

2898'

3001

SCALE: 1" = 200'

0   100 200   400   600   800   1000

LEGEND

INDICATES TRACT BOUNDARY

INDICATES WATERSHED BOUNDARY

INDICATES SUB-AREA BOUNDARY

INDICATES SUB-AREA
INDICATES SUB-AREA ACREAGE
INDICATES RUN-OFF TRAVEL LENGTH

f   INDICATES NODE NUMBER

3340   INDICATES NODE ELEVATION

INDICATES CONCENTRATED STORM RUNOFF

INDICATES SHEET FLOW
STORM RUNOFF

DRAINAGE MAP
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