PRELIMINARY HYDROLOGY AND HYDRAULICS STUDY FOR 76 GAS STATION, 333 HWY 173 LAKE ARROWHEAD, CA 92352 APN: 0335-122-10

LAKE ARROWHEAD
CALIFORNIA

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NOVEMBER 24, 2020
REVISED: JANUARY 15, 2021, MARCH 3, 2021

This report has been prepared by or under the direction of the following registered civil engineer who attests to the technical information contained herein. The registered civil engineer has also judged the qualifications of any technical specialists providing engineering data upon which recommendations, conclusions, and decisions are based.

Joseph L. Castaneda RCE 59835 Registered Civil Engineer	03/03/2021 Date	Seal

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I. PURPOSE AND SCOPE

The purpose of this study is to evaluate the drainage patterns and potential runoff for APN 0335-122-10. Surface runoff flows from the southern end of the project site to the northern end, discharging onto State Route 173.

The scope of the study includes the following:

1. Determination of points of flow concentration and watershed subareas for onsite and offsite areas.
2. Determination of the 100-year peak storm flows based upon the pre-project and post-project onsite and offsite areas utilizing the Rational Method as outlined in the San Bernardino County Flood Control Hydrology Manual.
3. Preparation of a hydrology report, which consist of hydrological and analytical results and exhibits.

II. PROJECT SITE AND DRAINAGE AREA OVERVIEW

APN 0335-122-10 is a proposed gas station on 0.47 acres of land. The project site is bounded by State Route 173 to the north, by a building and parking lot to the southwest, and by a small patch of wooded area to the southeast. The project site is located in the County of San Bernardino in the community of Lake Arrowhead.

The existing project site area is currently undeveloped, with minimal vegetation since the land is graded and compacted. Runoff from the upstream building and parking lot area currently enter the site on the southwest edge and sheet flow to the northeast, discharging onto State Route 173. The proposed project will include curbs and retaining walls to direct runoff. As shown on the plot plan, the project will be graded in a manner that will prevent off-site street runoff from entering the property. The flows from the upstream area will be directed onto State Highway 173 at the western corner of the project rather than flow across the site. Runoff from the project site will be directed to the northeast edge where it will discharge onto State Highway 173.

III. HYDROLOGY

The San Bernardino County Hydrology Manual (Reference 1), was used to develop the hydrological parameters for the hydrology analyses. The USDA Part 630 Hydrology of the National Engineering Handbook (Reference 2) was used for additional hydrological parameters. The rational method was used for the analyses and the computations were performed using the computer program developed by Civil Cadd/Civil Design.

Rainfall depths were obtained from NOAA Atlas 14, which has been included as Excerpt A. The rainfall depths used in the hydrology calculations for the rational method are as follows:

Storm Event & Duration	Rainfall (inches)
10-Year, 1-Hour	1.71

100-Year, 1-Hour	2.87
Slope of Intensity	0.70

The existing soil classification for the on-site area consists of Hydrologic Soil Group "D", as shown in Excerpt B. Excerpt B is a Soils Map obtained from the National Resource Conservation Service Websoil Survey. An Antecedent Moisture Condition of II was used for the 10-year and 100-year calculations.

The hydrology utilized the following land use covers:

Land Use Cover	Runoff Index Number (Soil "D")	Pervious Ratio
Undeveloped, Average Cover	84	1
Commercial	75	0.1
Pavement	98	0.01
Barren	93	1

Site specific topography was provided by the client and used in conjunction with obtained USGS topography. The USGS topography was used for a regional understanding of the area. The site specific topography is more accurate than the USGS topography since the USGS topography was created on a larger scale. Therefore, the site specific topography was used for elevation values for the rational method analysis. The benchmark elevation of 100 feet for the site specific topography corresponds to a USGS elevation of 5232 feet, with a delta difference of 5131 feet. This delta difference was used to obtain an elevation for Node 101 and Node 102, which are located offsite..

The rational method analysis analyzed Area A which consisted of 3 sub-boundary areas in the pre-project condition. In comparison to the post-project condition which used 5 sub-boundary areas. The pre-project and post-project conditions include the onsite area and an area offsite to the southwest. The runoff in both conditions discharges onto State Route 173. Runoff within drainage Area A reaches a downstream point on State Route 173 at the eastern corner of the site. This downstream point was used for comparison between the pre-project and post-project conditions, the results of which are shown in the table below:

	Q_{100} (CFS)	T_C (min)	Q_{10} (CFS)	T_C (min)
Pre-Project	9.26	9.24	5.34	9.48
Post-Project	9.19	9.34	5.32	9.59
Delta	-0.07	+0.1	-0.02	+0.11

The results show an approximate 0.8% decrease. The decrease in flow rate can be attributed to the increase in the time of concentration. The following contributed to the increase in time of concentration:

- The flow length increased from the pre-project to the post-project condition. The pre-project flow line traveled in a direct path to the downstream node.

- Walls and curbs are proposed to be added to the project site which will increase the flow length. The walls and curbs direct the flow path away from the direct path across the site.

The time of concentration is one of the most important values within a rational method analysis. The runoff is calculated based on the intensity which is based on the time of concentration. In this case, enough is similar between the pre-project and post-project conditions that the increase in time of concentration causes a small decrease in the flowrate.

The major change between the pre-project and post-project condition is in the change of land cover from barren to commercial. The barren land cover that presently exists on the project site is graded and compacted which does not allow for much infiltration potential. The proposed commercial land cover is primarily impervious but is calculated to contain 10% commercial landscaping, which has better infiltration potential that barren land. This difference is reflected in their Runoff Index numbers. The maximum loss rate, Fm, offers a comparison of the infiltration potential. For the pre-project project site area the Fm value is 0.018 inches/hour. For the post-project site area the Fm value is 0.017 inches/hour. These two values are nearly the same, which indicates that the pre-project and post-project conditions will have similar runoff potential.

The pre-project rational method hydrology calculations have been included in Appendix A, and the pre-project rational method hydrology map has been included as Exhibit A. The post-project rational method hydrology calculations have been included in Appendix B, and post-project rational method hydrology map has been included as Exhibit B.

IV. FINDINGS

The hydrology analysis evaluated the proposed commercial development to determine the potential runoff from the site. It has been concluded that:

1. The overall drainage area has not changed between the pre-project and post-project condition.
2. The land cover has changed from a graded compacted condition to a paved surface for commercial use, including commercial landscaping.
3. The post-project condition results in a longer flow path in comparison to the pre-project condition within the project site.
4. The flow rate from the drainage area decreased from the pre-project condition to the post-project condition. The decrease associated with the 100 year storm event is approximately 0.07 ft^3/s. The decrease associated with the 10 year storm evens is approximately 0.03 ft^3/s.
5. It can be concluded the project development will not cause an increase in the flowrate emanating from the project site.

V. REFERENCES

1. San Bernardino Flood Control Hydrology Manual, August 1986.
2. USDA National Engineering Handbook, Part 630 Hydrology, Chapter 9, July 2004

FIGURES

FIGURE 1: VICINITY MAP

VICINITY MAP

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FIGURE 1

Drawing Name: O:\293.01.20\Engineering\Hydrology_Plan\Exhibits\VICINITY MAP.dwg
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APPENDICES

APPENDIX A: PRE-PROJECT CONDITION RATIONAL METHOD HYDROLOGY

APPENDIX A.1: RATIONAL METHOD ANALYSIS, AREAS "A"

100-YEAR STORM EVENT

San Bernardino County Rational Hydrology Program

(Hydrology Manual Date - August 1986)

CIVILCADD/CIVILDESIGN Engineering Software, (c) 1989-2014 Version 9.0
Rational Hydrology Study Date: 03/01/21

293.01.20
RATIONAL METHOD ANALYSIS, TOTAL AREA=0.97 AC
100 YEAR, FILE NAME: ARAEX100

Program License Serial Number 6279

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

Rational hydrology study storm event year is 100.0
Computed rainfall intensity:
Storm year = 100.00 1 hour rainfall = 2.870 (In.)
Slope used for rainfall intensity curve b = 0.7000
Soil antecedent moisture condition (AMC) = 3

++
Process from Point/Station 101.000 to Point/Station 102.000
**** INITIAL AREA EVALUATION ****

UNDEVELOPED (average cover) subarea
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
SCS curve number for soil(AMC 2) = 84.00
Adjusted SCS curve number for AMC 3 = 96.40
Pervious ratio(Ap) = 1.0000 Max loss rate(Fm)= 0.071(In/Hr)
Initial subarea data:
Initial area flow distance = 110.000(Ft.)
Top (of initial area) elevation = 122.000(Ft.)
Bottom (of initial area) elevation = 113.300(Ft.)
Difference in elevation = 8.700(Ft.)
Slope = 0.07909 s(%)= 7.91
TC = k(0.706)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration = 7.687 min.
Rainfall intensity = 12.094(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.895
Subarea runoff = 1.515(CFS)
Total initial stream area = 0.140(Ac.)
Pervious area fraction = 1.000
Initial area Fm value = 0.071(In/Hr)

++
Process from Point/Station 102.000 to Point/Station 103.000
**** IMPROVED CHANNEL TRAVEL TIME ****

```
Upstream point elevation =   113.300(Ft.)
Downstream point elevation =    96.700(Ft.)
Channel length thru subarea  =   113.000(Ft.)
Channel base width      =    5.000(Ft.)
Slope or 'Z' of left channel bank = 100.000
Slope or 'Z' of right channel bank = 100.000
Estimated mean flow rate at midpoint of channel =      2.404(CFS)
Manning's 'N'    = 0.015
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =      2.404(CFS)
Depth of flow =   0.055(Ft.), Average velocity =   4.151(Ft/s)
Channel flow top width =   16.020(Ft.)
Flow Velocity =    4.15(Ft/s)
Travel time  =    0.45 min.
Time of concentration =    8.14 min.
Critical depth =      0.107(Ft.)
 Adding area flow to channel
COMMERCIAL subarea type
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
SCS curve number for soil(AMC 2)  = 75.00
Adjusted SCS curve number for AMC 3 = 91.00
Pervious ratio(Ap) = 0.1000     Max loss rate(Fm)=     0.017(In/Hr)
Rainfall intensity =     11.618(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.897
Subarea runoff =      1.715(CFS) for    0.170(Ac.)
Total runoff =      3.230(CFS)
Effective area this stream =        0.31(Ac.)
Total Study Area (Main Stream No. 1) =        0.31(Ac.)
Area averaged Fm value =    0.042(In/Hr)
Depth of flow =   0.063(Ft.), Average velocity =   4.491(Ft/s)
Critical depth =      0.123(Ft.)


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Process from Point/Station      103.000 to Point/Station      104.000
**** IMPROVED CHANNEL TRAVEL TIME ****
------------------------------------------------------------------------
Upstream point elevation =    96.700(Ft.)
Downstream point elevation =    78.300(Ft.)
Channel length thru subarea  =   227.000(Ft.)
Channel base width      =    5.000(Ft.)
Slope or 'Z' of left channel bank =  50.000
Slope or 'Z' of right channel bank =  50.000
Estimated mean flow rate at midpoint of channel =      6.274(CFS)
Manning's 'N'    = 0.025
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =      6.274(CFS)
Depth of flow =   0.147(Ft.), Average velocity =   3.453(Ft/s)
Channel flow top width =   19.707(Ft.)
Flow Velocity =    3.45(Ft/s)
Travel time  =    1.10 min.
Time of concentration =    9.24 min.
Critical depth =      0.205(Ft.)
 Adding area flow to channel
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```
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 94.00
Adjusted SCS curve number for AMC 3 = 98.80
Pervious ratio(Ap) = 0.7600     Max loss rate(Fm)=     0.018(In/Hr)
Rainfall intensity =     10.635(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.898
Subarea runoff =      6.032(CFS) for    0.660(Ac.)
Total runoff =      9.262(CFS)
Effective area this stream =        0.97(Ac.)
Total Study Area (Main Stream No. 1) =        0.97(Ac.)
Area averaged Fm value =    0.026(In/Hr)
Depth of flow =   0.176(Ft.), Average velocity =   3.822(Ft/s)
Critical depth =      0.248(Ft.)
End of computations, Total Study Area =            0.97 (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) = 0.679
Area averaged SCS curve number =  89.2
```

10-YEAR STORM EVENT

San Bernardino County Rational Hydrology Program

(Hydrology Manual Date - August 1986)

CIVILCADD/CIVILDESIGN Engineering Software, (c) 1989-2014 Version 9.0
Rational Hydrology Study Date: 03/01/21

293.01.20
RATIONAL METHOD ANALYSIS, TOTAL AREA=0.97 AC
10 YEAR, FILE NAME: ARAEX10

Program License Serial Number 6279

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

Rational hydrology study storm event year is 10.0
Computed rainfall intensity:
Storm year = 10.00 1 hour rainfall = 1.710 (In.)
Slope used for rainfall intensity curve b = 0.7000
Soil antecedent moisture condition (AMC) = 2

++
Process from Point/Station 101.000 to Point/Station 102.000
**** INITIAL AREA EVALUATION ****

UNDEVELOPED (average cover) subarea
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
SCS curve number for soil(AMC 2) = 84.00
Pervious ratio(Ap) = 1.0000 Max loss rate(Fm)= 0.301(In/Hr)
Initial subarea data:
Initial area flow distance = 110.000(Ft.)
Top (of initial area) elevation = 122.000(Ft.)
Bottom (of initial area) elevation = 113.300(Ft.)
Difference in elevation = 8.700(Ft.)
Slope = 0.07909 s(%)= 7.91
TC = k(0.706)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration = 7.687 min.
Rainfall intensity = 7.206(In/Hr) for a 10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.862
Subarea runoff = 0.870(CFS)
Total initial stream area = 0.140(Ac.)
Pervious area fraction = 1.000
Initial area Fm value = 0.301(In/Hr)

++
Process from Point/Station 102.000 to Point/Station 103.000
**** IMPROVED CHANNEL TRAVEL TIME ****

```
Upstream point elevation =   113.300(Ft.)
Downstream point elevation =    96.700(Ft.)
Channel length thru subarea  =   113.000(Ft.)
Channel base width      =    5.000(Ft.)
Slope or 'Z' of left channel bank = 100.000
Slope or 'Z' of right channel bank = 100.000
Estimated mean flow rate at midpoint of channel =      1.398(CFS)
Manning's 'N'    = 0.015
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =      1.398(CFS)
Depth of flow =   0.042(Ft.), Average velocity =   3.583(Ft/s)
Channel flow top width =   13.457(Ft.)
Flow Velocity =    3.58(Ft/s)
Travel time  =    0.53 min.
Time of concentration =    8.21 min.
Critical depth =      0.083(Ft.)
 Adding area flow to channel
COMMERCIAL subarea type
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
SCS curve number for soil(AMC 2)  = 75.00
Pervious ratio(Ap) = 0.1000     Max loss rate(Fm)=     0.045(In/Hr)
Rainfall intensity =      6.880(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.879
Subarea runoff =      1.005(CFS) for    0.170(Ac.)
Total runoff =      1.875(CFS)
Effective area this stream =        0.31(Ac.)
Total Study Area (Main Stream No. 1) =        0.31(Ac.)
Area averaged Fm value =    0.161(In/Hr)
Depth of flow =   0.049(Ft.), Average velocity =   3.882(Ft/s)
Critical depth =      0.095(Ft.)


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Process from Point/Station      103.000 to Point/Station      104.000
**** IMPROVED CHANNEL TRAVEL TIME ****
------------------------------------------------------------------------
Upstream point elevation =    96.700(Ft.)
Downstream point elevation =    78.300(Ft.)
Channel length thru subarea  =   227.000(Ft.)
Channel base width      =    5.000(Ft.)
Slope or 'Z' of left channel bank =  50.000
Slope or 'Z' of right channel bank =  50.000
Estimated mean flow rate at midpoint of channel =      3.639(CFS)
Manning's 'N'    = 0.025
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =      3.639(CFS)
Depth of flow =   0.114(Ft.), Average velocity =   2.990(Ft/s)
Channel flow top width =   16.383(Ft.)
Flow Velocity =    2.99(Ft/s)
Travel time  =    1.27 min.
Time of concentration =    9.48 min.
Critical depth =      0.158(Ft.)
 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) = 94.00
Pervious ratio(Ap) = 0.7600 Max loss rate(Fm)= 0.089(In/Hr)
Rainfall intensity = 6.223(In/Hr) for a 10.0 year storm
Effective runoff coefficient used for area,(total area with modified rational method)(Q=KCIA) is C = 0.884
Subarea runoff = 3.461(CFS) for 0.660(Ac.)
Total runoff = 5.335(CFS)
Effective area this stream = 0.97(Ac.)
Total Study Area (Main Stream No. 1) = 0.97(Ac.)
Area averaged Fm value = 0.112(In/Hr)
Depth of flow = 0.136(Ft.), Average velocity = 3.309(Ft/s)
Critical depth = 0.191(Ft.)
End of computations, Total Study Area = 0.97 (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) = 0.679
Area averaged SCS curve number = 89.2

APPENDIX B: POST-PROJECT CONDITION RATIONAL METHOD HYDROLOGY

APPENDIX B.1: RATIONAL METHOD ANALYSIS, AREAS "A"

100-YEAR STORM EVENT

San Bernardino County Rational Hydrology Program

(Hydrology Manual Date - August 1986)

CIVILCADD/CIVILDESIGN Engineering Software, (c) 1989-2014 Version 9.0
Rational Hydrology Study Date: 03/01/21

293.01.20
RATIONAL METHOD ANALYSIS, TOTAL AREA=0.97 AC
100 YEAR, FILE NAME: ARAP100

Program License Serial Number 6279

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

Rational hydrology study storm event year is 100.0
Computed rainfall intensity:
Storm year = 100.00 1 hour rainfall = 2.870 (In.)
Slope used for rainfall intensity curve b = 0.7000
Soil antecedent moisture condition (AMC) = 3

++
Process from Point/Station 101.000 to Point/Station 102.000
**** INITIAL AREA EVALUATION ****

UNDEVELOPED (average cover) subarea
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
SCS curve number for soil(AMC 2) = 84.00
Adjusted SCS curve number for AMC 3 = 96.40
Pervious ratio(Ap) = 1.0000 Max loss rate(Fm)= 0.071(In/Hr)
Initial subarea data:
Initial area flow distance = 110.000(Ft.)
Top (of initial area) elevation = 122.000(Ft.)
Bottom (of initial area) elevation = 113.300(Ft.)
Difference in elevation = 8.700(Ft.)
Slope = 0.07909 s(%)= 7.91
TC = k(0.706)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration = 7.687 min.
Rainfall intensity = 12.094(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.895
Subarea runoff = 1.515(CFS)
Total initial stream area = 0.140(Ac.)
Pervious area fraction = 1.000
Initial area Fm value = 0.071(In/Hr)

++
Process from Point/Station 102.000 to Point/Station 103.000
**** IMPROVED CHANNEL TRAVEL TIME ****

```
Upstream point elevation =   113.300(Ft.)
Downstream point elevation =    97.900(Ft.)
Channel length thru subarea  =   135.000(Ft.)
Channel base width      =    5.000(Ft.)
Slope or 'Z' of left channel bank = 100.000
Slope or 'Z' of right channel bank = 100.000
Estimated mean flow rate at midpoint of channel =      2.447(CFS)
Manning's 'N'    = 0.015
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =      2.447(CFS)
Depth of flow =   0.059(Ft.), Average velocity =   3.802(Ft/s)
Channel flow top width =   16.807(Ft.)
Flow Velocity =    3.80(Ft/s)
Travel time  =    0.59 min.
Time of concentration =    8.28 min.
Critical depth =      0.107(Ft.)
 Adding area flow to channel
COMMERCIAL subarea type
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
SCS curve number for soil(AMC 2)  = 75.00
Adjusted SCS curve number for AMC 3 = 91.00
Pervious ratio(Ap) = 0.1000     Max loss rate(Fm)=     0.017(In/Hr)
Rainfall intensity =     11.482(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.897
Subarea runoff =      1.780(CFS) for    0.180(Ac.)
Total runoff =      3.295(CFS)
Effective area this stream =        0.32(Ac.)
Total Study Area (Main Stream No. 1) =        0.32(Ac.)
Area averaged Fm value =    0.041(In/Hr)
Depth of flow =   0.068(Ft.), Average velocity =   4.113(Ft/s)
Critical depth =      0.124(Ft.)


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Process from Point/Station      103.000 to Point/Station      105.000
**** IMPROVED CHANNEL TRAVEL TIME ****
----------------------------------------------------------------------
Upstream point elevation =    97.900(Ft.)
Downstream point elevation =    84.000(Ft.)
Channel length thru subarea  =   194.000(Ft.)
Channel base width      =    5.000(Ft.)
Slope or 'Z' of left channel bank = 100.000
Slope or 'Z' of right channel bank = 100.000
Estimated mean flow rate at midpoint of channel =      5.148(CFS)
Manning's 'N'    = 0.015
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =      5.148(CFS)
Depth of flow =   0.093(Ft.), Average velocity =   3.891(Ft/s)
Channel flow top width =   23.543(Ft.)
Flow Velocity =    3.89(Ft/s)
Travel time  =    0.83 min.
Time of concentration =    9.11 min.
Critical depth =      0.152(Ft.)
 Adding area flow to channel
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COMMERCIAL subarea type
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
SCS curve number for soil(AMC 2)  = 75.00
Adjusted SCS curve number for AMC 3 = 91.00
Pervious ratio(Ap) = 0.1000     Max loss rate(Fm)=     0.017(In/Hr)
Rainfall intensity =     10.738(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.898
Subarea runoff =      3.645(CFS) for    0.400(Ac.)
Total runoff =      6.940(CFS)
Effective area this stream =        0.72(Ac.)
Total Study Area (Main Stream No. 1) =        0.72(Ac.)
Area averaged Fm value =    0.028(In/Hr)
Depth of flow =   0.106(Ft.), Average velocity =   4.202(Ft/s)
Critical depth =      0.174(Ft.)


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Process from Point/Station      103.000 to Point/Station      105.000
**** CONFLUENCE OF MAIN STREAMS ****
------------------------------------------------------------------------
The following data inside Main Stream is listed:
In Main Stream number: 1
Stream flow area =      0.720(Ac.)
Runoff from this stream =      6.940(CFS)
Time of concentration =    9.11 min.
Rainfall intensity =    10.738(In/Hr)
Area averaged loss rate (Fm) =    0.0278(In/Hr)
Area averaged Pervious ratio (Ap) = 0.2750
Program is now starting with Main Stream No. 2


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Process from Point/Station      104.000 to Point/Station      105.000
**** INITIAL AREA EVALUATION ****
------------------------------------------------------------------------
COMMERCIAL subarea type
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
SCS curve number for soil(AMC 2)  = 75.00
Adjusted SCS curve number for AMC 3 = 91.00
Pervious ratio(Ap) = 0.1000     Max loss rate(Fm)=     0.017(In/Hr)
Initial subarea data:
Initial area flow distance =   252.000(Ft.)
Top (of initial area) elevation =    98.500(Ft.)
Bottom (of initial area) elevation =    84.000(Ft.)
Difference in elevation =    14.500(Ft.)
Slope =    0.05754  s(%)=       5.75
TC = k(0.304)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =    4.914 min.
Rainfall intensity =     16.542(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.899
Subarea runoff =      3.123(CFS)
Total initial stream area =        0.210(Ac.)
```

```
Pervious area fraction = 0.100
Initial area Fm value =    0.017(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      104.000 to Point/Station      105.000
**** CONFLUENCE OF MAIN STREAMS ****
------------------------------------------------------------------------
The following data inside Main Stream is listed:
In Main Stream number: 2
Stream flow area =      0.210(Ac.)
Runoff from this stream =      3.123(CFS)
Time of concentration =    4.91 min.
Rainfall intensity =    16.542(In/Hr)
Area averaged loss rate (Fm) =    0.0174(In/Hr)
Area averaged Pervious ratio (Ap) = 0.1000
Summary of stream data:

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


1      6.94     0.720      9.11    0.028     10.738
2      3.12     0.210      4.91    0.017     16.542
Qmax(1) =
         1.000 *    1.000 *     6.940) +
         0.649 *    1.000 *     3.123) + =       8.967
Qmax(2) =
         1.542 *    0.539 *     6.940) +
         1.000 *    1.000 *     3.123) + =       8.896

Total of 2 main streams to confluence:
Flow rates before confluence point:
       7.940       4.123
Maximum flow rates at confluence using above data:
        8.967        8.896
Area of streams before confluence:
        0.720        0.210
Effective area values after confluence:
        0.930        0.598


Results of confluence:
Total flow rate =      8.967(CFS)
Time of concentration =     9.110 min.
Effective stream area after confluence  =      0.930(Ac.)
Study area average Pervious fraction(Ap) =  0.235
Study area average soil loss rate(Fm) =    0.025(In/Hr)
Study area total =       0.93(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      105.000 to Point/Station      106.000
**** IMPROVED CHANNEL TRAVEL TIME ****
------------------------------------------------------------------------
Upstream point elevation =    84.000(Ft.)
Downstream point elevation =    78.300(Ft.)
Channel length thru subarea  =    85.000(Ft.)
Channel base width      =    0.100(Ft.)
```

```
Slope or 'Z' of left channel bank =  50.000
Slope or 'Z' of right channel bank =   0.000
Estimated mean flow rate at midpoint of channel =      9.119(CFS)
Manning's 'N'    = 0.015
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =      9.119(CFS)
Depth of flow =   0.241(Ft.), Average velocity =   6.202(Ft/s)
Channel flow top width =   12.126(Ft.)
Flow Velocity =    6.20(Ft/s)
Travel time  =    0.23 min.
Time of concentration =    9.34 min.
Critical depth =      0.381(Ft.)
 Adding area flow to channel
COMMERCIAL subarea type
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
SCS curve number for soil(AMC 2)  = 75.00
Adjusted SCS curve number for AMC 3 = 91.00
Pervious ratio(Ap) = 0.1000     Max loss rate(Fm)=     0.017(In/Hr)
Rainfall intensity =     10.554(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.898
Subarea runoff =      0.225(CFS) for    0.040(Ac.)
Total runoff =      9.192(CFS)
Effective area this stream =        0.97(Ac.)
Total Study Area (Main Stream No. 1) =        0.97(Ac.)
Area averaged Fm value =    0.025(In/Hr)
Depth of flow =   0.241(Ft.), Average velocity =   6.214(Ft/s)
Critical depth =      0.383(Ft.)
End of computations, Total Study Area =            0.97 (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) = 0.230
Area averaged SCS curve number =  76.3
```

10-YEAR STORM EVENT

San Bernardino County Rational Hydrology Program

(Hydrology Manual Date - August 1986)

CIVILCADD/CIVILDESIGN Engineering Software, (c) 1989-2014 Version 9.0
Rational Hydrology Study Date: 03/01/21

293.01.20
RATIONAL METHOD ANALYSIS, TOTAL AREA=0.97 AC
10 YEAR, FILE NAME: ARAP10

Program License Serial Number 6279

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

Rational hydrology study storm event year is 10.0
Computed rainfall intensity:
Storm year = 10.00 1 hour rainfall = 1.710 (In.)
Slope used for rainfall intensity curve b = 0.7000
Soil antecedent moisture condition (AMC) = 2

++
Process from Point/Station 101.000 to Point/Station 102.000
**** INITIAL AREA EVALUATION ****

UNDEVELOPED (average cover) subarea
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
SCS curve number for soil(AMC 2) = 84.00
Pervious ratio(Ap) = 1.0000 Max loss rate(Fm)= 0.301(In/Hr)
Initial subarea data:
Initial area flow distance = 110.000(Ft.)
Top (of initial area) elevation = 122.000(Ft.)
Bottom (of initial area) elevation = 113.300(Ft.)
Difference in elevation = 8.700(Ft.)
Slope = 0.07909 s(%)= 7.91
TC = k(0.706)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration = 7.687 min.
Rainfall intensity = 7.206(In/Hr) for a 10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.862
Subarea runoff = 0.870(CFS)
Total initial stream area = 0.140(Ac.)
Pervious area fraction = 1.000
Initial area Fm value = 0.301(In/Hr)

++
Process from Point/Station 102.000 to Point/Station 103.000
**** IMPROVED CHANNEL TRAVEL TIME ****

```
Upstream point elevation =   113.300(Ft.)
Downstream point elevation =    97.900(Ft.)
Channel length thru subarea  =   135.000(Ft.)
Channel base width      =    5.000(Ft.)
Slope or 'Z' of left channel bank = 100.000
Slope or 'Z' of right channel bank = 100.000
Estimated mean flow rate at midpoint of channel =      1.429(CFS)
Manning's 'N'    = 0.015
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =      1.429(CFS)
Depth of flow =   0.046(Ft.), Average velocity =   3.289(Ft/s)
Channel flow top width =   14.101(Ft.)
Flow Velocity =    3.29(Ft/s)
Travel time  =    0.68 min.
Time of concentration =    8.37 min.
Critical depth =      0.083(Ft.)
 Adding area flow to channel
COMMERCIAL subarea type
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
SCS curve number for soil(AMC 2)  = 75.00
Pervious ratio(Ap) = 0.1000     Max loss rate(Fm)=     0.045(In/Hr)
Rainfall intensity =      6.788(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.879
Subarea runoff =      1.040(CFS) for    0.180(Ac.)
Total runoff =      1.910(CFS)
Effective area this stream =        0.32(Ac.)
Total Study Area (Main Stream No. 1) =        0.32(Ac.)
Area averaged Fm value =    0.157(In/Hr)
Depth of flow =   0.052(Ft.), Average velocity =   3.557(Ft/s)
Critical depth =      0.096(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      103.000 to Point/Station      105.000
**** IMPROVED CHANNEL TRAVEL TIME ****
------------------------------------------------------------------------
Upstream point elevation =    97.900(Ft.)
Downstream point elevation =    84.000(Ft.)
Channel length thru subarea  =   194.000(Ft.)
Channel base width      =    5.000(Ft.)
Slope or 'Z' of left channel bank = 100.000
Slope or 'Z' of right channel bank = 100.000
Estimated mean flow rate at midpoint of channel =      2.999(CFS)
Manning's 'N'    = 0.015
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =      2.999(CFS)
Depth of flow =   0.072(Ft.), Average velocity =   3.380(Ft/s)
Channel flow top width =   19.490(Ft.)
Flow Velocity =    3.38(Ft/s)
Travel time  =    0.96 min.
Time of concentration =    9.33 min.
Critical depth =      0.119(Ft.)
 Adding area flow to channel
COMMERCIAL subarea type
Decimal fraction soil group A = 0.000
```

```
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
SCS curve number for soil(AMC 2)  = 75.00
Pervious ratio(Ap) = 0.1000     Max loss rate(Fm)=     0.045(In/Hr)
Rainfall intensity =      6.293(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.886
Subarea runoff =      2.107(CFS) for    0.400(Ac.)
Total runoff =      4.017(CFS)
Effective area this stream =        0.72(Ac.)
Total Study Area (Main Stream No. 1) =        0.72(Ac.)
Area averaged Fm value =    0.095(In/Hr)
Depth of flow =   0.083(Ft.), Average velocity =   3.648(Ft/s)
Critical depth =      0.136(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      103.000 to Point/Station      105.000
**** CONFLUENCE OF MAIN STREAMS ****
------------------------------------------------------------------------
The following data inside Main Stream is listed:
In Main Stream number: 1
Stream flow area =      0.720(Ac.)
Runoff from this stream =      4.017(CFS)
Time of concentration =    9.33 min.
Rainfall intensity =     6.293(In/Hr)
Area averaged loss rate (Fm) =    0.0949(In/Hr)
Area averaged Pervious ratio (Ap) = 0.2750
Program is now starting with Main Stream No. 2


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      104.000 to Point/Station      105.000
**** INITIAL AREA EVALUATION ****
------------------------------------------------------------------------
COMMERCIAL subarea type
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
SCS curve number for soil(AMC 2)  = 75.00
Pervious ratio(Ap) = 0.1000     Max loss rate(Fm)=     0.045(In/Hr)
Initial subarea data:
Initial area flow distance =   252.000(Ft.)
Top (of initial area) elevation =    98.500(Ft.)
Bottom (of initial area) elevation =    84.000(Ft.)
Difference in elevation =    14.500(Ft.)
Slope =    0.05754  s(%)=       5.75
TC = k(0.304)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =    4.914 min.
Rainfall intensity =      9.856(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.896
Subarea runoff =      1.854(CFS)
Total initial stream area =        0.210(Ac.)
Pervious area fraction = 0.100
Initial area Fm value =    0.045(In/Hr)
```

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++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      104.000 to Point/Station      105.000
**** CONFLUENCE OF MAIN STREAMS ****
------------------------------------------------------------------------------
The following data inside Main Stream is listed:
In Main Stream number: 2
Stream flow area =      0.210(Ac.)
Runoff from this stream =      1.854(CFS)
Time of concentration =    4.91 min.
Rainfall intensity =     9.856(In/Hr)
Area averaged loss rate (Fm) =    0.0453(In/Hr)
Area averaged Pervious ratio (Ap) = 0.1000
Summary of stream data:

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


1      4.02     0.720      9.33    0.095      6.293
2      1.85     0.210      4.91    0.045      9.856
Qmax(1) =
         1.000 *    1.000 *     4.017) +
         0.637 *    1.000 *     1.854) + =       5.197
Qmax(2) =
         1.575 *    0.527 *     4.017) +
         1.000 *    1.000 *     1.854) + =       5.187

Total of 2 main streams to confluence:
Flow rates before confluence point:
       5.017       2.854
Maximum flow rates at confluence using above data:
        5.197        5.187
Area of streams before confluence:
        0.720        0.210
Effective area values after confluence:
        0.930        0.589


Results of confluence:
Total flow rate =      5.197(CFS)
Time of concentration =     9.327 min.
Effective stream area after confluence  =      0.930(Ac.)
Study area average Pervious fraction(Ap) =  0.235
Study area average soil loss rate(Fm) =    0.084(In/Hr)
Study area total =       0.93(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      105.000 to Point/Station      106.000
**** IMPROVED CHANNEL TRAVEL TIME ****
------------------------------------------------------------------------------
Upstream point elevation =    84.000(Ft.)
Downstream point elevation =    78.300(Ft.)
Channel length thru subarea  =    85.000(Ft.)
Channel base width      =    0.100(Ft.)
Slope or 'Z' of left channel bank =  50.000
Slope or 'Z' of right channel bank =   0.000
Estimated mean flow rate at midpoint of channel =      5.283(CFS)
Manning's 'N'    = 0.015
```

```
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =      5.283(CFS)
Depth of flow =   0.196(Ft.), Average velocity =   5.411(Ft/s)
Channel flow top width =    9.882(Ft.)
Flow Velocity =    5.41(Ft/s)
Travel time  =    0.26 min.
Time of concentration =    9.59 min.
Critical depth =      0.307(Ft.)
 Adding area flow to channel
COMMERCIAL subarea type
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
SCS curve number for soil(AMC 2)  = 75.00
Pervious ratio(Ap) = 0.1000     Max loss rate(Fm)=     0.045(In/Hr)
Rainfall intensity =      6.172(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.888
Subarea runoff =      0.119(CFS) for    0.040(Ac.)
Total runoff =      5.317(CFS)
Effective area this stream =        0.97(Ac.)
Total Study Area (Main Stream No. 1) =        0.97(Ac.)
Area averaged Fm value =    0.082(In/Hr)
Depth of flow =   0.196(Ft.), Average velocity =   5.420(Ft/s)
Critical depth =      0.307(Ft.)
End of computations, Total Study Area =            0.97 (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) = 0.230
Area averaged SCS curve number =  76.3
```

EXCERPTS

EXCERPT A: NOAA RAINFALL TABLE

NOAA Atlas 14, Volume 6, Version 2
Location name: Lake Arrowhead, California, USA*
Latitude: 34.2473°, Longitude: -117.1908°
Elevation: 5238.14 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.226** (0.187-0.275)	**0.297** (0.246-0.362)	**0.395** (0.326-0.483)	**0.479** (0.393-0.591)	**0.601** (0.476-0.767)	**0.700** (0.543-0.912)	**0.806** (0.610-1.08)	**0.921** (0.678-1.26)	**1.09** (0.766-1.56)	**1.22** (0.832-1.81)
10-min	**0.324** (0.269-0.394)	**0.425** (0.352-0.518)	**0.566** (0.468-0.692)	**0.687** (0.563-0.847)	**0.862** (0.683-1.10)	**1.00** (0.779-1.31)	**1.16** (0.875-1.54)	**1.32** (0.971-1.81)	**1.56** (1.10-2.23)	**1.75** (1.19-2.60)
15-min	**0.392** (0.325-0.477)	**0.514** (0.426-0.627)	**0.685** (0.565-0.837)	**0.831** (0.681-1.02)	**1.04** (0.825-1.33)	**1.21** (0.942-1.58)	**1.40** (1.06-1.87)	**1.60** (1.17-2.19)	**1.88** (1.33-2.70)	**2.12** (1.44-3.14)
30-min	**0.563** (0.467-0.685)	**0.738** (0.612-0.901)	**0.983** (0.812-1.20)	**1.19** (0.978-1.47)	**1.50** (1.19-1.91)	**1.74** (1.35-2.27)	**2.01** (1.52-2.68)	**2.29** (1.69-3.15)	**2.70** (1.91-3.87)	**3.04** (2.07-4.51)
60-min	**0.804** (0.667-0.979)	**1.06** (0.874-1.29)	**1.40** (1.16-1.72)	**1.71** (1.40-2.10)	**2.14** (1.69-2.73)	**2.49** (1.93-3.25)	**2.87** (2.17-3.83)	**3.28** (2.41-4.50)	**3.86** (2.72-5.53)	**4.34** (2.96-6.44)
2-hr	**1.16** (0.961-1.41)	**1.52** (1.26-1.86)	**2.03** (1.68-2.49)	**2.47** (2.03-3.05)	**3.11** (2.46-3.97)	**3.63** (2.82-4.73)	**4.19** (3.17-5.59)	**4.79** (3.53-6.58)	**5.67** (4.00-8.12)	**6.39** (4.35-9.48)
3-hr	**1.45** (1.21-1.77)	**1.91** (1.58-2.33)	**2.54** (2.10-3.11)	**3.09** (2.53-3.81)	**3.88** (3.07-4.94)	**4.52** (3.51-5.89)	**5.21** (3.94-6.96)	**5.96** (4.38-8.19)	**7.04** (4.97-10.1)	**7.93** (5.40-11.8)
6-hr	**2.13** (1.76-2.59)	**2.79** (2.31-3.40)	**3.71** (3.07-4.54)	**4.50** (3.69-5.55)	**5.63** (4.46-7.18)	**6.55** (5.08-8.53)	**7.53** (5.70-10.1)	**8.58** (6.31-11.8)	**10.1** (7.12-14.5)	**11.3** (7.71-16.8)
12-hr	**2.97** (2.46-3.62)	**3.99** (3.31-4.87)	**5.38** (4.44-6.58)	**6.54** (5.36-8.07)	**8.18** (6.48-10.4)	**9.47** (7.35-12.3)	**10.8** (8.19-14.5)	**12.3** (9.02-16.8)	**14.3** (10.1-20.4)	**15.9** (10.8-23.6)
24-hr	**4.26** (3.78-4.91)	**5.91** (5.23-6.82)	**8.11** (7.16-9.38)	**9.94** (8.70-11.6)	**12.5** (10.6-15.0)	**14.4** (12.0-17.8)	**16.5** (13.4-20.8)	**18.6** (14.7-24.1)	**21.6** (16.3-29.1)	**23.9** (17.5-33.4)
2-day	**5.61** (4.97-6.46)	**7.92** (7.01-9.14)	**11.1** (9.75-12.8)	**13.7** (12.0-15.9)	**17.3** (14.7-20.9)	**20.3** (16.8-24.9)	**23.3** (18.9-29.4)	**26.5** (20.9-34.4)	**31.0** (23.5-41.9)	**34.7** (25.3-48.4)
3-day	**6.25** (5.54-7.20)	**8.91** (7.88-10.3)	**12.5** (11.1-14.5)	**15.6** (13.7-18.2)	**20.0** (16.9-24.1)	**23.5** (19.5-28.9)	**27.2** (22.0-34.3)	**31.2** (24.6-40.3)	**36.8** (27.8-49.6)	**41.3** (30.2-57.6)
4-day	**6.78** (6.01-7.81)	**9.71** (8.59-11.2)	**13.7** (12.1-15.9)	**17.2** (15.0-20.0)	**22.1** (18.7-26.6)	**26.1** (21.6-32.1)	**30.3** (24.6-38.2)	**34.9** (27.5-45.1)	**41.3** (31.3-55.8)	**46.6** (34.1-65.1)
7-day	**7.79** (6.90-8.97)	**11.1** (9.81-12.8)	**15.7** (13.9-18.2)	**19.7** (17.3-23.0)	**25.5** (21.6-30.7)	**30.3** (25.1-37.2)	**35.4** (28.7-44.6)	**41.0** (32.3-53.1)	**49.1** (37.1-66.2)	**55.8** (40.8-77.9)
10-day	**8.42** (7.46-9.70)	**12.0** (10.6-13.8)	**17.0** (15.0-19.6)	**21.3** (18.7-24.8)	**27.7** (23.5-33.3)	**32.9** (27.3-40.5)	**38.6** (31.3-48.7)	**44.9** (35.4-58.1)	**54.0** (40.8-72.8)	**61.6** (45.0-85.9)
20-day	**10.0** (8.86-11.5)	**14.3** (12.7-16.5)	**20.5** (18.1-23.7)	**25.8** (22.6-30.1)	**33.7** (28.5-40.6)	**40.2** (33.3-49.4)	**47.2** (38.2-59.4)	**54.9** (43.3-71.1)	**66.1** (50.0-89.2)	**75.5** (55.2-105)
30-day	**11.7** (10.3-13.4)	**16.8** (14.9-19.4)	**24.0** (21.2-27.8)	**30.3** (26.5-35.3)	**39.4** (33.4-47.4)	**46.9** (38.9-57.7)	**55.0** (44.5-69.2)	**63.8** (50.3-82.6)	**76.6** (57.9-103)	**87.3** (63.8-122)
45-day	**14.0** (12.4-16.1)	**20.0** (17.7-23.1)	**28.4** (25.1-32.9)	**35.7** (31.2-41.6)	**46.1** (39.1-55.6)	**54.6** (45.3-67.2)	**63.7** (51.6-80.2)	**73.6** (58.0-95.2)	**87.7** (66.4-118)	**99.4** (72.7-139)
60-day	**16.3** (14.5-18.8)	**23.2** (20.5-26.7)	**32.6** (28.8-37.7)	**40.7** (35.6-47.4)	**52.1** (44.2-62.8)	**61.4** (50.9-75.5)	**71.2** (57.7-89.7)	**81.7** (64.4-106)	**96.7** (73.2-130)	**109** (79.7-152)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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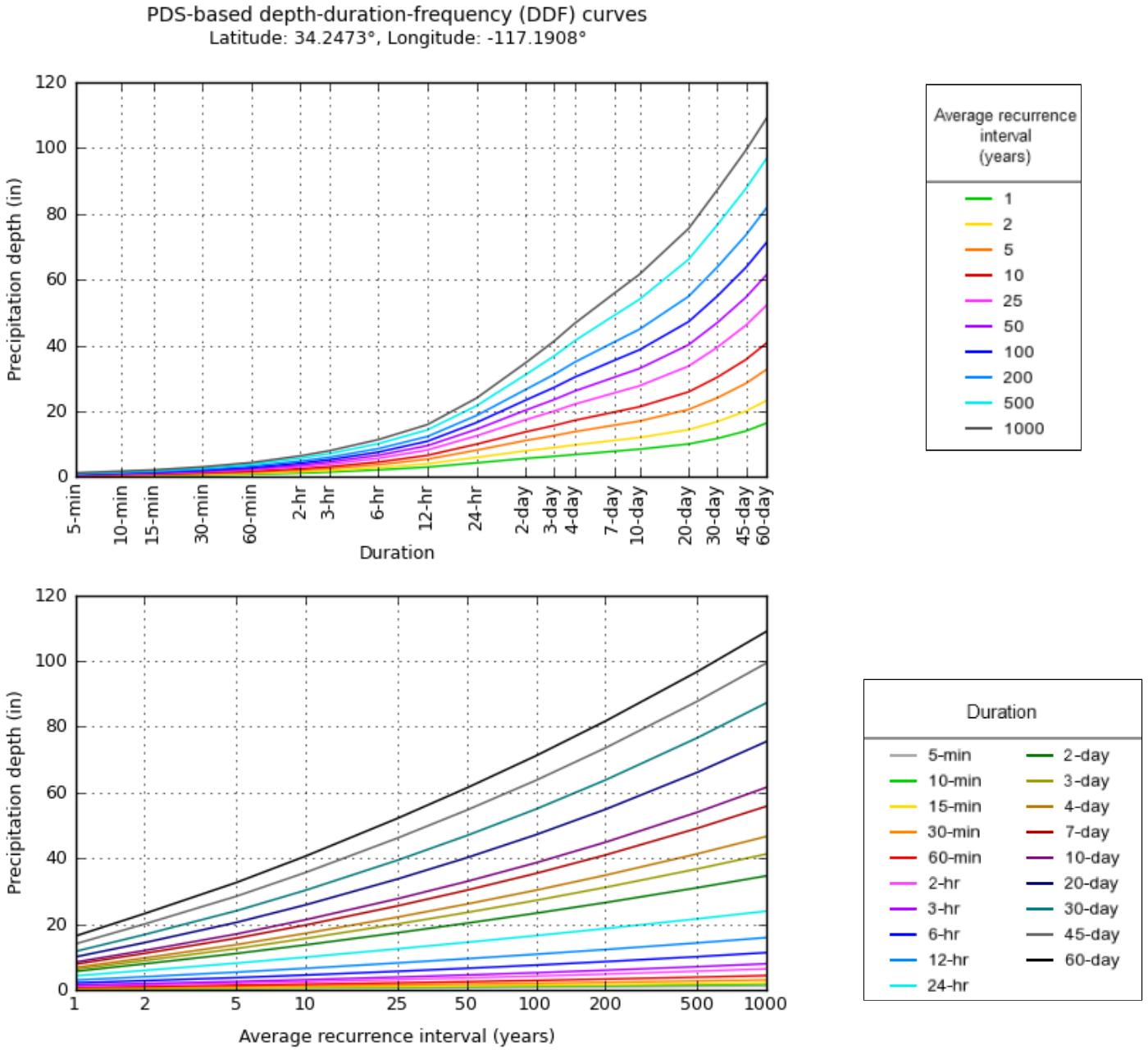
PF graphical



NOAA Atlas 14, Volume 6, Version 2

Created (GMT): Tue Nov 24 18:29:05 2020

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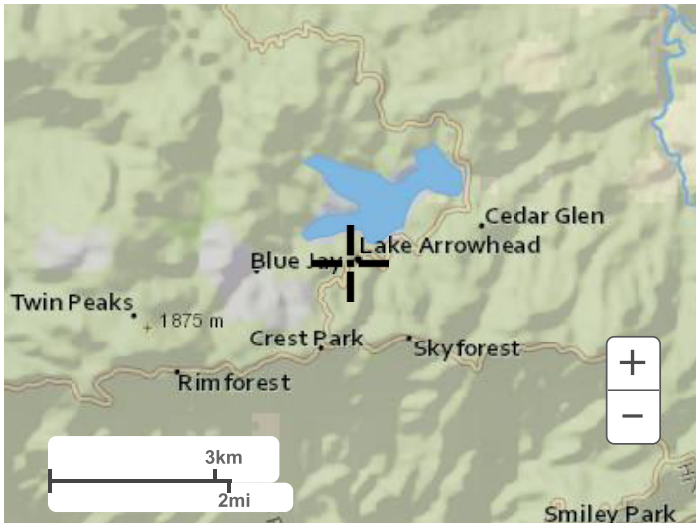
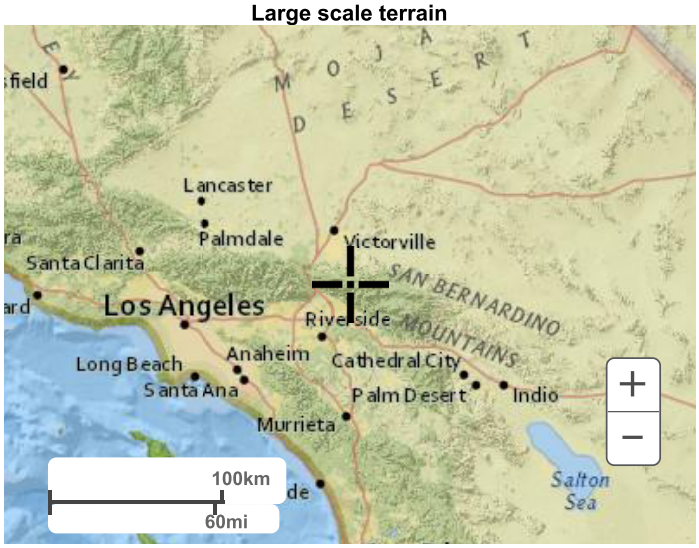
Maps & aerials

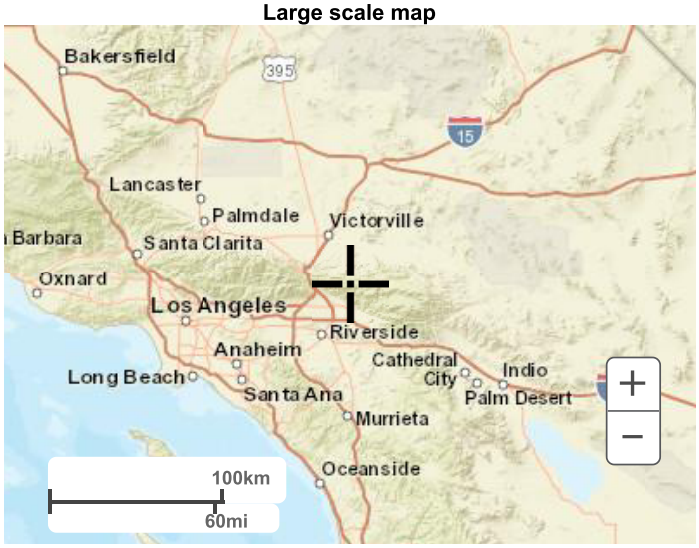
Small scale terrain



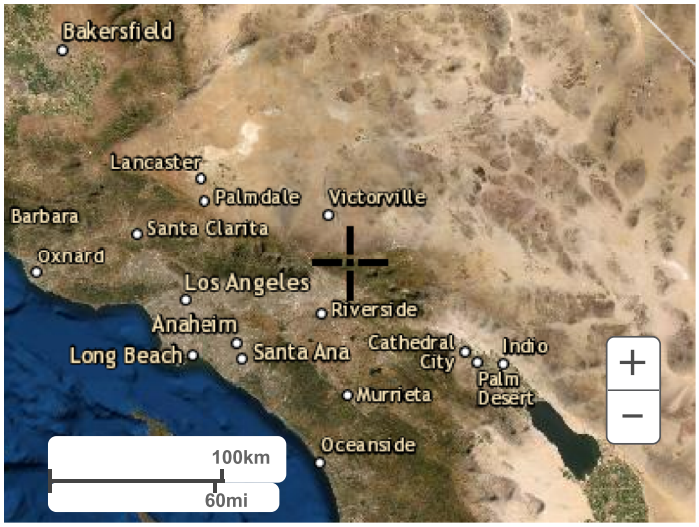
Large scale terrain



Large scale map



Large scale aerial



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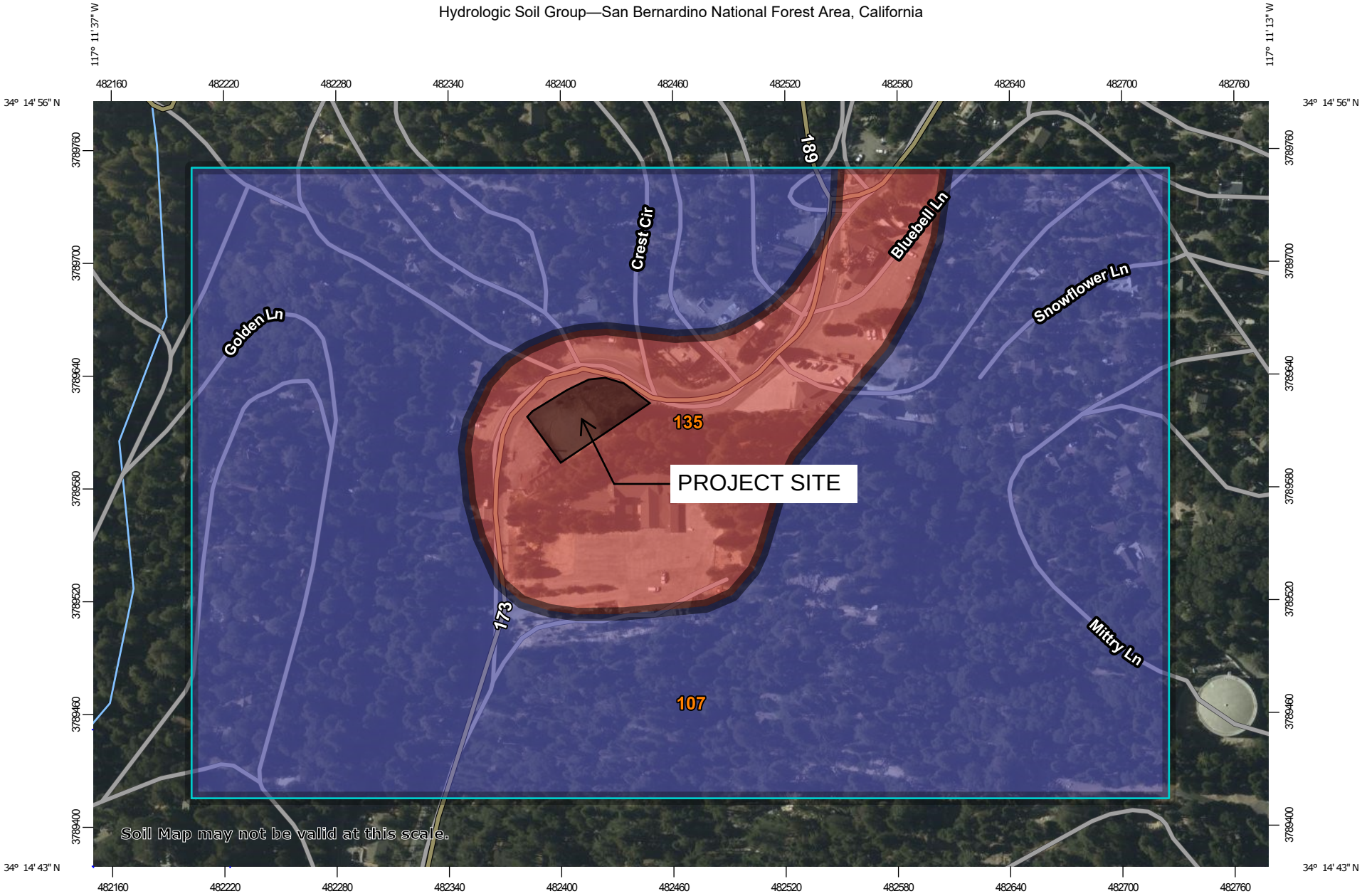
US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

EXCERPT B: NRCS HYDRAULIC SOILS MAP



Map Scale: 1:2,870 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 40 80 160 240

Feet: 0 100 200 400 600

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 11N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Lines

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Points

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: San Bernardino National Forest Area, California
Survey Area Data: Version 12, May 27, 2020

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 26, 2019—Jul 8, 2019

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
107	Cedarpines-Stargazer-Urban land complex, 30 to 50 percent slopes	B	35.9	82.5%
135	Urban land	D	7.6	17.5%
Totals for Area of Interest			**43.5**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

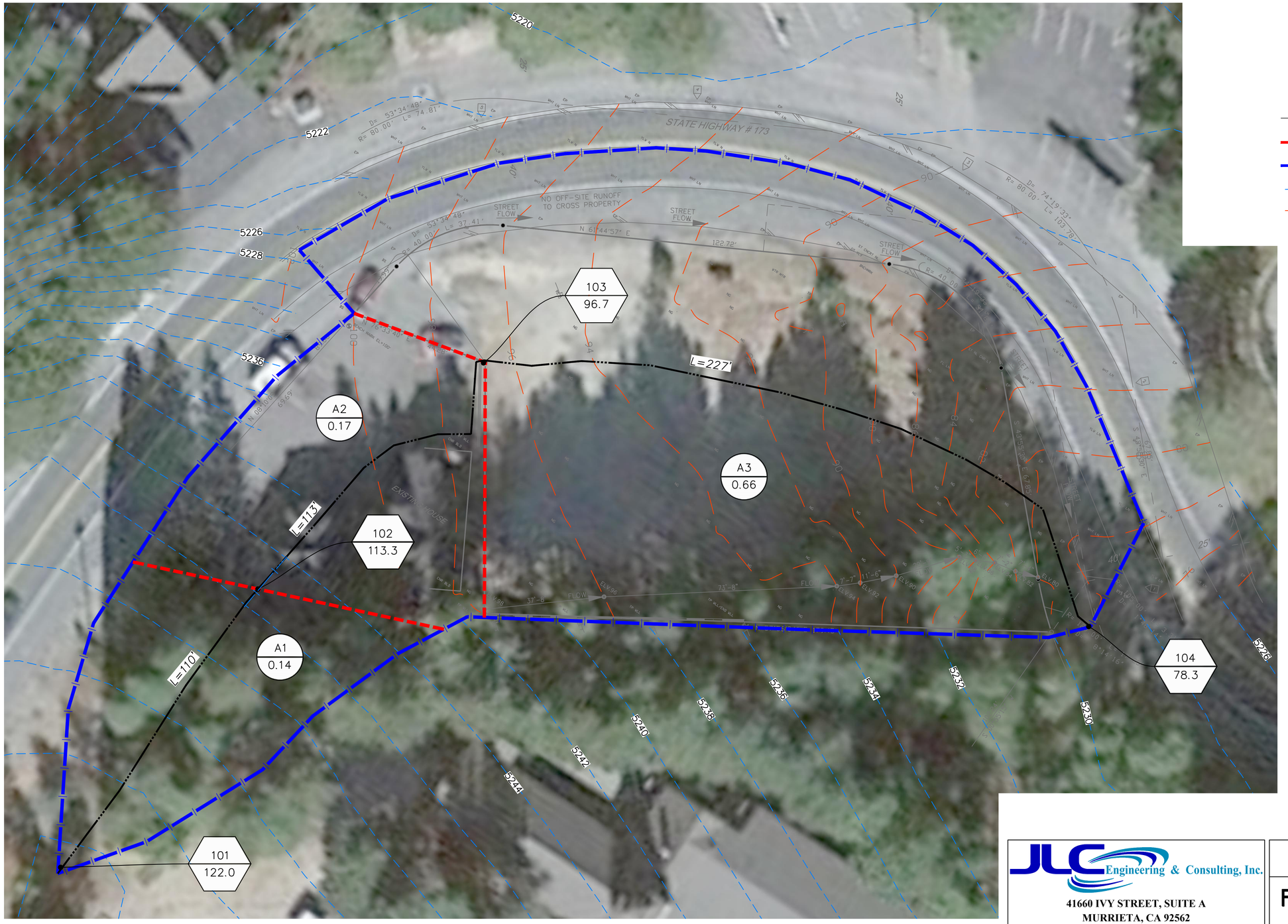
EXHIBITS

EXHIBIT A: PRE-PROJECT CONDITION RATIONAL METHOD HYDROLOGY MAP

APN 0335-122-10 (P201800510)

IN LAKE ARROWHEAD, COUNTY OF SAN BERNARDINO, STATE OF CALIFORNIA

PRE-PROJECT CONDITION SITE HYDROLOGY MAP



LEGEND:

- X.X / X.X — NODE/CONCENTRATION POINT, FLOWLINE ELEVATION (SITE SPECIFIC)
- XXX / X.X — SUB AREA, ACRES
- L=XXX' — FLOW DISTANCE
- FLOW PATH
- WATERSHED SUB-BOUNDARY
- WATERSHED BOUNDARY
- 5232 — USGS TOPOGRAPHY
- 100 — SITE SPECIFIC TOPOGRAPHY

NOTE: THE USGS TOPOGRAPHY ELEVATION OF 5232 IS A COMMON BASE ELEVATION TO THE SITE SPECIFIC TOPOGRAPHY ELEVATION OF 100

HYDROLOGY SUMMARY TABLE

NODE TO NODE		Q_{100} (CFS)	T_C (MIN)	Q_{10} (CFS)	T_C (MIN)
101	102	1.52	7.69	0.87	7.69
102	103	3.23	8.14	1.88	8.21
103	104	9.26	9.24	5.34	9.48

SCALE 1"=15'

GRAPHIC SCALE
15' 0 7.5' 15' 30'
1" = 15'

JLC Engineering & Consulting, Inc.
41660 IVY STREET, SUITE A
MURRIETA, CA 92562
PH. 951.304.9552 FAX 951.304.3568

EXHIBIT "A"

PRE-PROJECT CONDITION SITE HYDROLOGY MAP

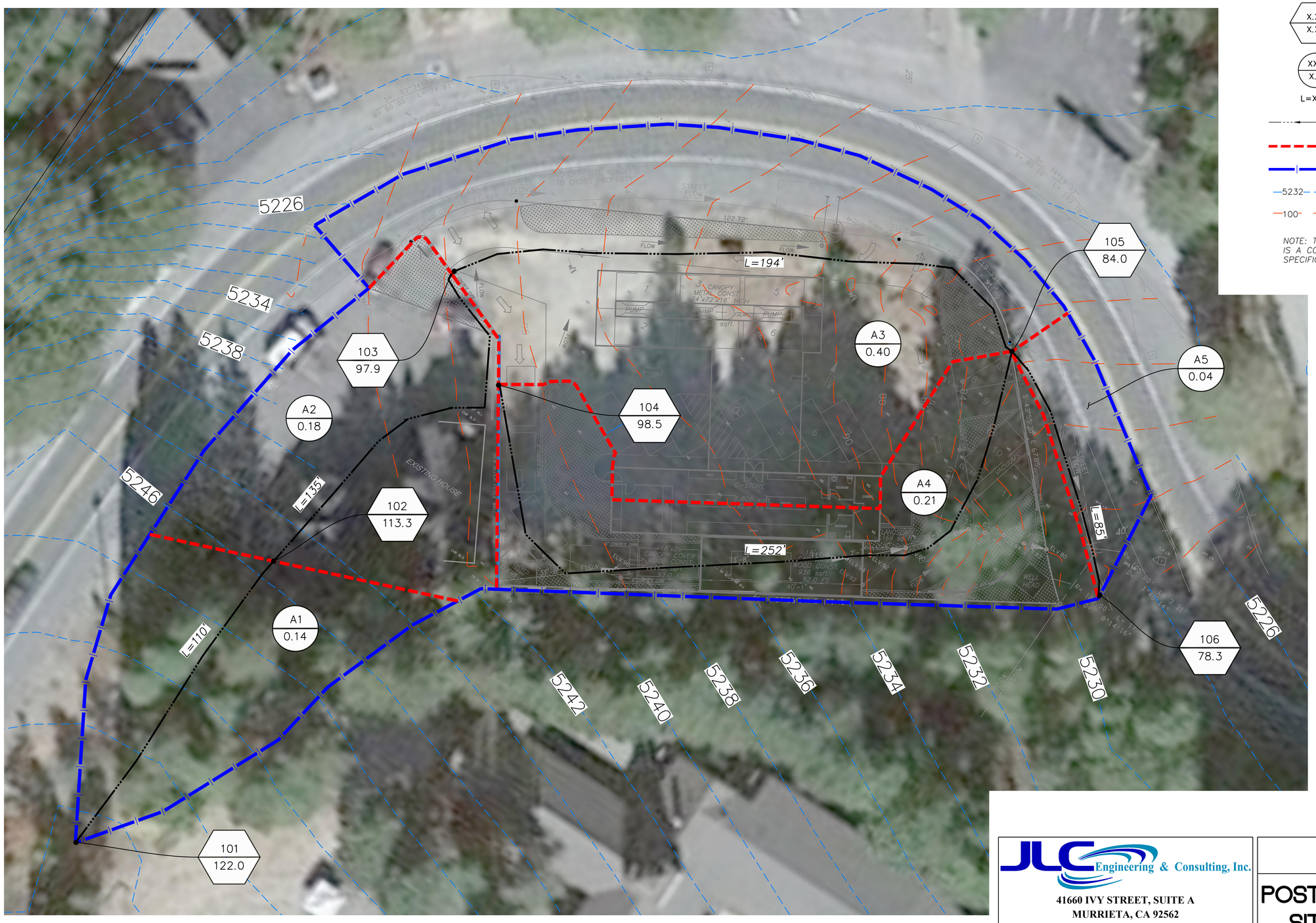
Drawing Name: G:\293.01.20\Engineering\Hydrology_Plan\Exhibits\293.01.20-Hydrology_Map-Pre.dwg
Last Opened: Mar 03, 2021 - 8:58pm by sdang

EXHIBIT B: POST-PROJECT CONDITION RATIONAL METHOD HYDROLOGY MAP

APN 0335-122-10 (P201800510)

IN LAKE ARROWHEAD, COUNTY OF SAN BERNARDINO, STATE OF CALIFORNIA

POST-PROJECT CONDITION SITE HYDROLOGY MAP



LEGEND:

- X.X / X.X — NODE/CONCENTRATION POINT, FLOWLINE ELEVATION (SITE SPECIFIC)
- XXX / X.X — SUB AREA, ACRES
- L=XXX' — FLOW DISTANCE
- FLOW PATH
- WATERSHED SUB-BOUNDARY
- WATERSHED BOUNDARY
- 5232 — USGS TOPOGRAPHY
- 100 — SITE SPECIFIC TOPOGRAPHY

NOTE: THE USGS TOPOGRAPHY ELEVATION OF 5232 IS A COMMON BASE ELEVATION TO THE SITE SPECIFIC TOPOGRAPHY ELEVATION OF 100

HYDROLOGY SUMMARY TABLE

NODE TO NODE		Q_{100} (CFS)	T_C (MIN)	Q_{10} (CFS)	T_C (MIN)
101	102	1.52	7.69	0.87	7.69
102	103	3.30	8.28	1.91	8.37
103	105	6.94	9.11	4.02	9.33
104	105	3.12	4.91	1.85	4.91
105	105	8.97	9.11	5.20	9.33
105	106	9.19	9.34	5.32	9.59

SCALE 1"=15'

GRAPHIC SCALE
15' 0 7.5' 15' 30'
1" = 15'

JLC Engineering & Consulting, Inc.
41660 IVY STREET, SUITE A
MURRIETA, CA 92562
PH. 951.304.9552 FAX 951.304.3568

EXHIBIT "B"

POST-PROJECT CONDITION SITE HYDROLOGY MAP

Drawing Name: G:\293.01.20\Engineering\Hydrology_Plan\Exhibits\293.01.20-Hydrology_Map-Post.dwg
Last Opened: Mar 03, 2021 - 5:39pm by steiner