DRAINAGE STUDY FOR BARTON ROAD IMPROVEMENTS

CITY OF COLTON
CALIFORNIA

PREPARED FOR:

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JANUARY 15, 2020
REVISED MARCH 2, 2020

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.

03/02/2020

Joseph L. Castaneda RCE 59835 Registered Civil Engineer	Date	Seal

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I. PURPOSE AND SCOPE

The Barton Road improvements are proposed roadway improvements that will be performed as part of the removal of the existing bridge that crosses the existing railroad corridor. The project is located in the City of Colton and City of Grand Terrace, see Figure 1 Vicinity Map. The purpose of this study is to determine the pre-project and post-project hydrology runoff rates and the necessary drainage improvements required for the Barton Road Improvement Plans.

The scope of the study includes the following:

1. Determination of points of flow concentration and watershed subareas for the project areas.
2. Determination of 10-year and 100-year storm event flow rates within the project watershed area. The project area will utilize the Rational Method as outlined in the San Bernardino County Hydrology Manual.
3. Determine the limits of storm drain required to flood protect the project site, and meet the City of Colton and City of Grand Terrace street design criteria.
4. Preparation of a drainage report, which consist of hydrological and analytical results and exhibits.

II. PROJECT SITE AND DRAINAGE AREA OVERVIEW

The Barton Road Improvements is a project that consist of removing an existing bridge and preparing roadway improvements that will construct a roadway section within the existing Barton Road right-of-way as shown on Excerpt 1. The proposed sections for the Barton Road Improvements have been included in Figure 2. The project will be constructed from the existing limits of the I-215/Barton Road interchange to the east to South Terrace Avenue to the west, which totals approximately 1,000 linear feet of roadway.

The overall drainage area drains in the westerly direction; however, the railroad corridor drains in the northern direction towards the Santa Ana River. The I-215/Barton Road interchange construct inlets at the easterly limits of the project boundary and has included several new storm drain inlets and subsurface pipe to collect the runoff from the interchange area. The design concept will implement a design concept that perpetuate the existing drainage patterns in order not to impact existing downstream properties.

III. HYDROLOGY

The San Bernardino County Hydrology Manual (Reference 1), was used to develop the hydrological parameters for the hydrology analyses. The rational method was used for the analyses and the computations were performed using the CivilDesign Hydrology software.

The hydrology parameters for the project were obtained from the following sources:

- 100 Year and 10 Year Rainfall Data was obtained from NOAA Atlas 14.
- Soil Classification were based on NRCS Soil Map
- Land Cover and impervious area were obtained from San Bernardino County Hydrology Manual

The hydrology analyses performed for the project site was developed in the following manner:

1. A watershed area was identified for the project for the pre-project condition using topographic features and improvement plans obtained from Caltrans that is associated with the I-215/Barton Road Interchange Project. The watershed was divided into 4 drainage areas and the flow rates were identified to establish a baseline condition. The hydrology map for the pre-project condition has been included as Exhibit A.
2. A watershed area was identified for the project for the post-project condition using design concept shown in Excerpt 1 that was developed by CNS. The watershed was divided into 4 drainage areas and the flow rates were identified to compare the flow rates to the baseline condition. The hydrology map for the post-project condition has been included as Exhibit B.

   The hydrology analyses resulted in the following flow rates for the 4 drainage areas for the pre-project condition:

Table 1 – "Pre Project Condition" Peak Flow Rate for Drainage Areas

Subarea	Drainage Area (acres)	100-Year Flow Rate (ft^3/s)	10-Year Flow Rate (ft^3/s)
A	0.44	1.42	2.5
B	6.11	9.7	5.9
C	0.4	1.3	0.9
D	0.4	1.2	0.8

   The hydrology analyses resulted in the following flow rates for the 4 drainage areas for the post-project condition:

Table 2 – "Post Project Condition" Peak Flow Rate for Drainage Areas

Subarea	Drainage Area (acres)	100-Year Flow Rate (ft^3/s)	10-Year Flow Rate (ft^3/s)
A	0.15	0.41	0.26
B	6.56	12.2	7.5
C	0.4	1.2	0.8
D	0.4	1.2	0.8

The hydrology results for the Barton Road Improvements indicate that Area A flow rates decreased in the post-project condition and the flow rates increased in the post project condition for Area B. The changes in the flow rate can be attributed to the altering of drainage areas that

result from the removal of the existing bridge and the high point that exists over the railroad corridor that is depicted in Excerpt 1. Moreover, based on the overall drainage patterns, Area A and Area B both drain into the railroad corridor. Area A drains into the railroad corridor via the existing 39-inch storm drain shown on Exhibit C "Drainage Facilities Map. Area B runoff flows along the railroad corridor as a surface flow condition. In order to do a comparative analysis the sum of the flow rates for Area A and Area B should be compared to assess changes in the magnitude of the flow rate. The pre-project flow rate for area A and B equals 11.1 ft^3/s and is tributary to the railroad corridor for the 100 year storm event. The post-project flow rate for area A and B equals 12.6 ft^3/s and is tributary to the railroad corridor for the 100 year storm event. The change of flow rate is insignificant and will not adversely impact the downstream property owners. Area C and Area D remain unchanged.

The hydrology calculations have been included in Appendix A and Appendix B for the pre-project and post-project conditions, respectively.

IV. STORM DRAIN SYSTEMS

The Drainage Facilities Map, Exhibit A, provides the existing storm drain and proposed storm drain systems required to service the project. The project will be required to construct the following storm drain systems:

1. Construction of a 30-inch culvert that will be located under the proposed fill area that will replace the existing bridge structure. The 30-inch culvert will allow flows to be perpetuated from the south side to the north side in order to mimic the existing drainage pattern.
2. Construction of two inlet structures that will be located west of the existing bridge structure. The two inlets will intercept the street surface flow and convey the runoff to a proposed water quality BMP. After the low flows area treated, the runoff will be conveyed to the proposed 30-inch storm drain.
3. Construction of an 18-inch storm drain that will convey the runoff from the two existing inlets constructed by Caltrans into the proposed 30-inch culvert. The existing design connects to an existing circular inlet structure that connects to an existing 8-inch outlet pipe. This design is substandard and must be repaired to provide adequate flood protection for Barton Road.

The proposed inlets and storm drain identified have been sized sufficiently to intercept the project runoff. It should be noted, that the system may change once more detailed design data and topographical mapping is obtained.

V. FINDINGS

The hydrology analyses evaluated the proposed runoff conditions for the pre-project and post-project conditions. It has been concluded that:

1. The proposed drainage facilities shown in Exhibit C will adequately convey the 100-year flows and provide flood protection to the project site.
2. The project will not adversely impact downstream properties since the flow rates are similar between the pre-project and post-project condition. The negligible change in the flow rate will not result in change in that will induce erosion or increase flooding.

VI. REFERENCES

1. San Bernardino County Hydrology Manual
2. Caltrans Preliminary Drainage Report for Interstate 215/Barton Road, June 9, 2011
3. Caltrans Improvement Plans for Interstate 215/Barton Road, May 22, 2017

FIGURES

FIGURE 1: VICINITY MAP

BARTON ROAD IMPROVEMENTS VICINITY MAP

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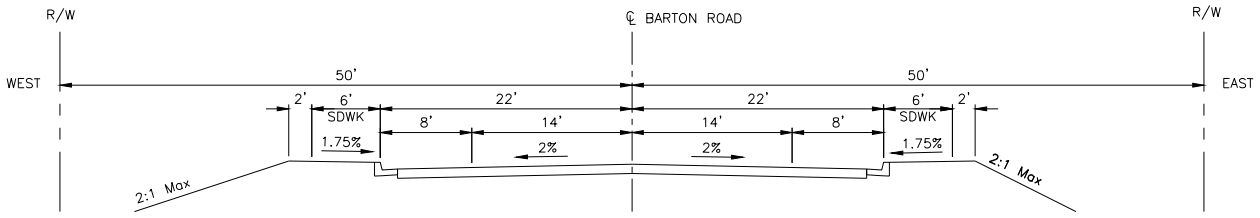
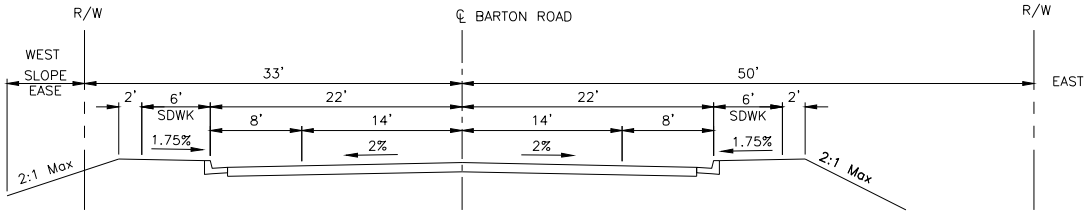
FIGURE 1

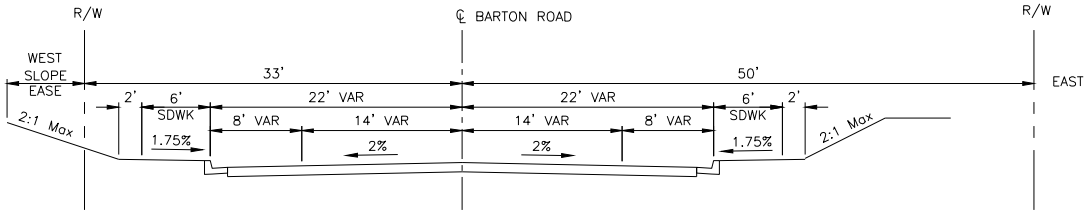
FIGURE 2: BARTON ROAD STREET SECTIONS



TYPICAL SECTION
STA. 30+25 TO 36+30±
NOT TO SCALE



TYPICAL SECTION
STA. 36+30± TO 37+75±
NOT TO SCALE



TYPICAL SECTION
STA. 37+75± TO 40+24
NOT TO SCALE

FIGURE 2 - BARTON ROAD TYPICAL SECTIONS

APPENDICES

APPENDIX A: PRE-PROJECT HYDROLOGY

APPENDIX A.1: 100 & 10-YEAR STORM EVENT – AREA "A"

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: 03/02/20

BARTON ROAD IMPROVEMENTS
100 YEAR HYDROLOGY ANALYSIS
FILENAME: ARAPR100

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 = 1.080 (In.)
Slope used for rainfall intensity curve b = 0.6000
Soil antecedent moisture condition (AMC) = 2

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

COMMERCIAL subarea type
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2) = 32.00
Pervious ratio(Ap) = 0.1000 Max loss rate(Fm)= 0.098(In/Hr)
Initial subarea data:
Initial area flow distance = 443.000(Ft.)
Top (of initial area) elevation = 979.000(Ft.)
Bottom (of initial area) elevation = 971.000(Ft.)
Difference in elevation = 8.000(Ft.)
Slope = 0.01806 s(%)= 1.81
TC = k(0.304)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration = 7.764 min.
Rainfall intensity = 3.683(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.876
Subarea runoff = 1.420(CFS)
Total initial stream area = 0.440(Ac.)
Pervious area fraction = 0.100
Initial area Fm value = 0.098(In/Hr)
End of computations, Total Study Area = 0.44 (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) = 0.100
Area averaged SCS curve number = 32.0

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: 03/02/20

BARTON ROAD IMPROVEMENTS
100 YEAR HYDROLOGY ANALYSIS
FILENAME: ARAPR100

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 = 1.080 (In.)
Slope used for rainfall intensity curve b = 0.6000
Soil antecedent moisture condition (AMC) = 2

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

COMMERCIAL subarea type
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2) = 32.00
Pervious ratio(Ap) = 0.1000 Max loss rate(Fm)= 0.098(In/Hr)
Initial subarea data:
Initial area flow distance = 443.000(Ft.)
Top (of initial area) elevation = 979.000(Ft.)
Bottom (of initial area) elevation = 971.000(Ft.)
Difference in elevation = 8.000(Ft.)
Slope = 0.01806 s(%)= 1.81
TC = k(0.304)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration = 7.764 min.
Rainfall intensity = 3.683(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.876
Subarea runoff = 1.420(CFS)
Total initial stream area = 0.440(Ac.)
Pervious area fraction = 0.100
Initial area Fm value = 0.098(In/Hr)
End of computations, Total Study Area = 0.44 (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) = 0.100
Area averaged SCS curve number = 32.0

APPENDIX A.2: 100 & 10-YEAR STORM EVENT – AREA "B"

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: 03/02/20

BARTON ROAD IMPROVEMENTS
100 YEAR HYDROLOGY ANALYSIS
FILENAME: ARBEX100

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 = 1.080 (In.)
Slope used for rainfall intensity curve b = 0.6000
Soil antecedent moisture condition (AMC) = 2

++

Process from Point/Station 200.000 to Point/Station 201.000
**** INITIAL AREA EVALUATION ****

COMMERCIAL subarea type
Decimal fraction soil group A = 0.550
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.450
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2) = 48.65
Pervious ratio(Ap) = 0.1000 Max loss rate(Fm)= 0.083(In/Hr)
Initial subarea data:
Initial area flow distance = 565.000(Ft.)
Top (of initial area) elevation = 981.000(Ft.)
Bottom (of initial area) elevation = 971.000(Ft.)
Difference in elevation = 10.000(Ft.)
Slope = 0.01770 s(%)= 1.77
TC = k(0.304)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration = 8.592 min.
Rainfall intensity = 3.466(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.879
Subarea runoff = 2.710(CFS)
Total initial stream area = 0.890(Ac.)
Pervious area fraction = 0.100
Initial area Fm value = 0.083(In/Hr)

++

Process from Point/Station 201.000 to Point/Station 202.000
**** IMPROVED CHANNEL TRAVEL TIME ****

Upstream point elevation = 971.000(Ft.)
Downstream point elevation = 955.000(Ft.)

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Channel length thru subarea  =   689.000(Ft.)
Channel base width      =    0.000(Ft.)
Slope or 'Z' of left channel bank =  20.000
Slope or 'Z' of right channel bank =  20.000
Estimated mean flow rate at midpoint of channel =      6.108(CFS)
Manning's 'N'    = 0.015
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =      6.108(CFS)
Depth of flow =   0.276(Ft.), Average velocity =   4.023(Ft/s)
Channel flow top width =   11.020(Ft.)
Flow Velocity =    4.02(Ft/s)
Travel time  =    2.85 min.
Time of concentration =   11.45 min.
Critical depth =      0.357(Ft.)
 Adding area flow to channel
COMMERCIAL subarea type
Decimal fraction soil group A = 0.840
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.160
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 37.92
Pervious ratio(Ap) = 0.1000     Max loss rate(Fm)=     0.094(In/Hr)
Rainfall intensity =      2.918(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.872
Subarea runoff =      6.730(CFS) for    2.820(Ac.)
Total runoff =      9.440(CFS)
Effective area this stream =        3.71(Ac.)
Total Study Area (Main Stream No. 1) =        3.71(Ac.)
Area averaged Fm value =    0.091(In/Hr)
Depth of flow =   0.324(Ft.), Average velocity =   4.486(Ft/s)
Critical depth =      0.426(Ft.)


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Process from Point/Station      202.000 to Point/Station      203.000
**** IMPROVED CHANNEL TRAVEL TIME ****
________________________________________________________________________
Upstream point elevation =   955.000(Ft.)
Downstream point elevation =   953.000(Ft.)
Channel length thru subarea  =   401.000(Ft.)
Channel base width      =    5.000(Ft.)
Slope or 'Z' of left channel bank =   4.000
Slope or 'Z' of right channel bank =   4.000
Estimated mean flow rate at midpoint of channel =      9.474(CFS)
Manning's 'N'    = 0.035
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =      9.474(CFS)
Depth of flow =   0.666(Ft.), Average velocity =   1.855(Ft/s)
Channel flow top width =   10.330(Ft.)
Flow Velocity =    1.86(Ft/s)
Travel time  =    3.60 min.
Time of concentration =   15.05 min.
Critical depth =      0.426(Ft.)
 Adding area flow to channel
UNDEVELOPED (poor cover) subarea
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 67.00
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Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.578(In/Hr)
The area added to the existing stream causes a
a lower flow rate of Q =      9.417(CFS)
therefore the upstream flow rate of Q =      9.440(CFS) is being used
Rainfall intensity =      2.476(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.834
Subarea runoff =      0.000(CFS) for    0.850(Ac.)
Total runoff =      9.440(CFS)
Effective area this stream =        4.56(Ac.)
Total Study Area (Main Stream No. 1) =        4.56(Ac.)
Area averaged Fm value =    0.182(In/Hr)
Depth of flow =   0.665(Ft.), Average velocity =   1.853(Ft/s)
Critical depth =      0.426(Ft.)


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Process from Point/Station      203.000 to Point/Station      204.000
**** IMPROVED CHANNEL TRAVEL TIME ****
________________________________________________________________________
Upstream point elevation =   953.000(Ft.)
Downstream point elevation =   952.000(Ft.)
Channel length thru subarea  =   461.000(Ft.)
Channel base width      =    5.000(Ft.)
Slope or 'Z' of left channel bank =   4.000
Slope or 'Z' of right channel bank =   4.000
Estimated mean flow rate at midpoint of channel =      9.609(CFS)
Manning's 'N'    = 0.035
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =      9.609(CFS)
Depth of flow =   0.834(Ft.), Average velocity =   1.383(Ft/s)
Channel flow top width =   11.668(Ft.)
Flow Velocity =    1.38(Ft/s)
Travel time  =    5.55 min.
Time of concentration =   20.60 min.
Critical depth =      0.430(Ft.)
 Adding area flow to channel
UNDEVELOPED (poor cover) subarea
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 67.00
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.578(In/Hr)
Rainfall intensity =      2.051(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.776
Subarea runoff =      0.285(CFS) for    1.550(Ac.)
Total runoff =      9.725(CFS)
Effective area this stream =        6.11(Ac.)
Total Study Area (Main Stream No. 1) =        6.11(Ac.)
Area averaged Fm value =    0.282(In/Hr)
Depth of flow =   0.839(Ft.), Average velocity =   1.388(Ft/s)
Critical depth =      0.434(Ft.)
End of computations, Total Study Area =            6.11 (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) = 0.454
```

Area averaged SCS curve number = 50.9

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: 03/02/20

BARTON ROAD IMPROVEMENTS
10 YEAR HYDROLOGY ANALYSIS
FILENAME: ARBEX10

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 = 0.698 (In.)
Slope used for rainfall intensity curve b = 0.6000
Soil antecedent moisture condition (AMC) = 2

++

Process from Point/Station 200.000 to Point/Station 201.000
**** INITIAL AREA EVALUATION ****

COMMERCIAL subarea type
Decimal fraction soil group A = 0.550
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.450
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2) = 48.65
Pervious ratio(Ap) = 0.1000 Max loss rate(Fm)= 0.083(In/Hr)
Initial subarea data:
Initial area flow distance = 565.000(Ft.)
Top (of initial area) elevation = 981.000(Ft.)
Bottom (of initial area) elevation = 971.000(Ft.)
Difference in elevation = 10.000(Ft.)
Slope = 0.01770 s(%)= 1.77
TC = k(0.304)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration = 8.592 min.
Rainfall intensity = 2.240(In/Hr) for a 10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.867
Subarea runoff = 1.728(CFS)
Total initial stream area = 0.890(Ac.)
Pervious area fraction = 0.100
Initial area Fm value = 0.083(In/Hr)

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Process from Point/Station 201.000 to Point/Station 202.000
**** IMPROVED CHANNEL TRAVEL TIME ****

Upstream point elevation = 971.000(Ft.)
Downstream point elevation = 955.000(Ft.)

```
Channel length thru subarea  =   689.000(Ft.)
Channel base width      =    0.000(Ft.)
Slope or 'Z' of left channel bank =  20.000
Slope or 'Z' of right channel bank =  20.000
Estimated mean flow rate at midpoint of channel =      3.850(CFS)
Manning's 'N'    = 0.015
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =      3.850(CFS)
Depth of flow =   0.232(Ft.), Average velocity =   3.585(Ft/s)
Channel flow top width =    9.269(Ft.)
Flow Velocity =    3.58(Ft/s)
Travel time  =    3.20 min.
Time of concentration =   11.80 min.
Critical depth =      0.297(Ft.)
 Adding area flow to channel
COMMERCIAL subarea type
Decimal fraction soil group A = 0.840
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.160
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 37.92
Pervious ratio(Ap) = 0.1000     Max loss rate(Fm)=     0.094(In/Hr)
Rainfall intensity =      1.852(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.856
Subarea runoff =      4.153(CFS) for    2.820(Ac.)
Total runoff =      5.881(CFS)
Effective area this stream =        3.71(Ac.)
Total Study Area (Main Stream No. 1) =        3.71(Ac.)
Area averaged Fm value =    0.091(In/Hr)
Depth of flow =   0.272(Ft.), Average velocity =   3.986(Ft/s)
Critical depth =      0.352(Ft.)


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Process from Point/Station      202.000 to Point/Station      203.000
**** IMPROVED CHANNEL TRAVEL TIME ****
________________________________________________________________________
Upstream point elevation =   955.000(Ft.)
Downstream point elevation =   953.000(Ft.)
Channel length thru subarea  =   401.000(Ft.)
Channel base width      =    5.000(Ft.)
Slope or 'Z' of left channel bank =   4.000
Slope or 'Z' of right channel bank =   4.000
Estimated mean flow rate at midpoint of channel =      5.924(CFS)
Manning's 'N'    = 0.035
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =      5.924(CFS)
Depth of flow =   0.518(Ft.), Average velocity =   1.615(Ft/s)
Channel flow top width =    9.147(Ft.)
Flow Velocity =    1.62(Ft/s)
Travel time  =    4.14 min.
Time of concentration =   15.93 min.
Critical depth =      0.320(Ft.)
 Adding area flow to channel
UNDEVELOPED (poor cover) subarea
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 67.00
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Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.578(In/Hr)
The area added to the existing stream causes a
a lower flow rate of Q =      5.601(CFS)
therefore the upstream flow rate of Q =      5.881(CFS) is being used
Rainfall intensity =      1.547(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.794
Subarea runoff =      0.000(CFS) for    0.850(Ac.)
Total runoff =      5.881(CFS)
Effective area this stream =        4.56(Ac.)
Total Study Area (Main Stream No. 1) =        4.56(Ac.)
Area averaged Fm value =    0.182(In/Hr)
Depth of flow =   0.516(Ft.), Average velocity =   1.612(Ft/s)
Critical depth =      0.320(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      203.000 to Point/Station      204.000
**** IMPROVED CHANNEL TRAVEL TIME ****
________________________________________________________________________
Upstream point elevation =   953.000(Ft.)
Downstream point elevation =   952.000(Ft.)
Channel length thru subarea  =   461.000(Ft.)
Channel base width      =    5.000(Ft.)
Slope or 'Z' of left channel bank =   4.000
Slope or 'Z' of right channel bank =   4.000
Estimated mean flow rate at midpoint of channel =      5.913(CFS)
Manning's 'N'    = 0.035
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =      5.913(CFS)
Depth of flow =   0.647(Ft.), Average velocity =   1.204(Ft/s)
Channel flow top width =   10.177(Ft.)
Flow Velocity =    1.20(Ft/s)
Travel time  =    6.38 min.
Time of concentration =   22.31 min.
Critical depth =      0.320(Ft.)
 Adding area flow to channel
UNDEVELOPED (poor cover) subarea
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 67.00
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.578(In/Hr)
The area added to the existing stream causes a
a lower flow rate of Q =      5.396(CFS)
therefore the upstream flow rate of Q =      5.881(CFS) is being used
Rainfall intensity =      1.264(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.699
Subarea runoff =      0.000(CFS) for    1.550(Ac.)
Total runoff =      5.881(CFS)
Effective area this stream =        6.11(Ac.)
Total Study Area (Main Stream No. 1) =        6.11(Ac.)
Area averaged Fm value =    0.282(In/Hr)
Depth of flow =   0.645(Ft.), Average velocity =   1.202(Ft/s)
Critical depth =      0.320(Ft.)
End of computations, Total Study Area =           6.11 (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) = 0.454
Area averaged SCS curve number = 50.9

APPENDIX A.3: 100 & 10-YEAR STORM EVENT – AREA "C"

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: 01/14/20

BARTON ROAD IMPROVEMENTS
100 YEAR HYDROLOGY ANALYSIS
FILENAME: ARCEX100

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 = 1.080 (In.)
Slope used for rainfall intensity curve b = 0.6000
Soil antecedent moisture condition (AMC) = 2

++
Process from Point/Station 301.000 to Point/Station 302.000
**** INITIAL AREA EVALUATION ****

COMMERCIAL subarea type
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2) = 32.00
Pervious ratio(Ap) = 0.1000 Max loss rate(Fm)= 0.098(In/Hr)
Initial subarea data:
Initial area flow distance = 630.000(Ft.)
Top (of initial area) elevation = 979.000(Ft.)
Bottom (of initial area) elevation = 953.000(Ft.)
Difference in elevation = 26.000(Ft.)
Slope = 0.04127 s(%)= 4.13
TC = k(0.304)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration = 7.577 min.
Rainfall intensity = 3.738(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.876
Subarea runoff = 1.343(CFS)
Total initial stream area = 0.410(Ac.)
Pervious area fraction = 0.100
Initial area Fm value = 0.098(In/Hr)
End of computations, Total Study Area = 0.41 (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) = 0.100
Area averaged SCS curve number = 32.0

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: 01/14/20

BARTON ROAD IMPROVEMENTS
10 YEAR HYDROLOGY ANALYSIS
FILENAME: ARCEX10

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 = 0.698 (In.)
Slope used for rainfall intensity curve b = 0.6000
Soil antecedent moisture condition (AMC) = 2

++
Process from Point/Station 301.000 to Point/Station 302.000
**** INITIAL AREA EVALUATION ****

COMMERCIAL subarea type
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2) = 32.00
Pervious ratio(Ap) = 0.1000 Max loss rate(Fm)= 0.098(In/Hr)
Initial subarea data:
Initial area flow distance = 630.000(Ft.)
Top (of initial area) elevation = 979.000(Ft.)
Bottom (of initial area) elevation = 953.000(Ft.)
Difference in elevation = 26.000(Ft.)
Slope = 0.04127 s(%)= 4.13
TC = k(0.304)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration = 7.577 min.
Rainfall intensity = 2.416(In/Hr) for a 10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.864
Subarea runoff = 0.855(CFS)
Total initial stream area = 0.410(Ac.)
Pervious area fraction = 0.100
Initial area Fm value = 0.098(In/Hr)
End of computations, Total Study Area = 0.41 (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) = 0.100
Area averaged SCS curve number = 32.0

APPENDIX A.4: 100 & 10-YEAR STORM EVENT – AREA "D"

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: 01/14/20

BARTON ROAD IMPROVEMENTS
100 YEAR HYDROLOGY ANALYSIS
FILENAME: ARDEX100

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 = 1.080 (In.)
Slope used for rainfall intensity curve b = 0.6000
Soil antecedent moisture condition (AMC) = 2

++
Process from Point/Station 401.000 to Point/Station 402.000
**** INITIAL AREA EVALUATION ****

COMMERCIAL subarea type
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2) = 32.00
Pervious ratio(Ap) = 0.1000 Max loss rate(Fm)= 0.098(In/Hr)
Initial subarea data:
Initial area flow distance = 646.000(Ft.)
Top (of initial area) elevation = 979.000(Ft.)
Bottom (of initial area) elevation = 953.000(Ft.)
Difference in elevation = 26.000(Ft.)
Slope = 0.04025 s(%)= 4.02
TC = k(0.304)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration = 7.692 min.
Rainfall intensity = 3.704(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.876
Subarea runoff = 1.169(CFS)
Total initial stream area = 0.360(Ac.)
Pervious area fraction = 0.100
Initial area Fm value = 0.098(In/Hr)
End of computations, Total Study Area = 0.36 (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) = 0.100
Area averaged SCS curve number = 32.0

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: 01/14/20

BARTON ROAD IMPROVEMENTS
10 YEAR HYDROLOGY ANALYSIS
FILENAME: ARDEX10

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 = 0.698 (In.)
Slope used for rainfall intensity curve b = 0.6000
Soil antecedent moisture condition (AMC) = 2

++
Process from Point/Station 401.000 to Point/Station 402.000
**** INITIAL AREA EVALUATION ****

COMMERCIAL subarea type
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2) = 32.00
Pervious ratio(Ap) = 0.1000 Max loss rate(Fm)= 0.098(In/Hr)
Initial subarea data:
Initial area flow distance = 646.000(Ft.)
Top (of initial area) elevation = 979.000(Ft.)
Bottom (of initial area) elevation = 953.000(Ft.)
Difference in elevation = 26.000(Ft.)
Slope = 0.04025 s(%)= 4.02
TC = k(0.304)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration = 7.692 min.
Rainfall intensity = 2.394(In/Hr) for a 10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.863
Subarea runoff = 0.744(CFS)
Total initial stream area = 0.360(Ac.)
Pervious area fraction = 0.100
Initial area Fm value = 0.098(In/Hr)
End of computations, Total Study Area = 0.36 (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) = 0.100
Area averaged SCS curve number = 32.0

APPENDIX B: POST-PROJECT HYDROLOGY

APPENDIX B.1: 100 & 10-YEAR STORM EVENT – AREA "A"

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: 03/03/20

BARTON ROAD IMPROVEMENTS
100 YEAR HYDROLOGY ANALYSIS
FILENAME: ARAPR100

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 = 1.080 (In.)
Slope used for rainfall intensity curve b = 0.6000
Soil antecedent moisture condition (AMC) = 2

++

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

COMMERCIAL subarea type
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2) = 32.00
Pervious ratio(Ap) = 0.1000 Max loss rate(Fm)= 0.098(In/Hr)
Initial subarea data:
Initial area flow distance = 429.000(Ft.)
Top (of initial area) elevation = 973.000(Ft.)
Bottom (of initial area) elevation = 971.000(Ft.)
Difference in elevation = 2.000(Ft.)
Slope = 0.00466 s(%)= 0.47
TC = k(0.304)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration = 10.049 min.
Rainfall intensity = 3.155(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.872
Subarea runoff = 0.413(CFS)
Total initial stream area = 0.150(Ac.)
Pervious area fraction = 0.100
Initial area Fm value = 0.098(In/Hr)
End of computations, Total Study Area = 0.15 (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) = 0.100
Area averaged SCS curve number = 32.0

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: 03/03/20

BARTON ROAD IMPROVEMENTS
10 YEAR HYDROLOGY ANALYSIS
FILENAME: ARAPR10

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 = 0.698 (In.)
Slope used for rainfall intensity curve b = 0.6000
Soil antecedent moisture condition (AMC) = 2

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

COMMERCIAL subarea type
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2) = 32.00
Pervious ratio(Ap) = 0.1000 Max loss rate(Fm)= 0.098(In/Hr)
Initial subarea data:
Initial area flow distance = 429.000(Ft.)
Top (of initial area) elevation = 973.000(Ft.)
Bottom (of initial area) elevation = 971.000(Ft.)
Difference in elevation = 2.000(Ft.)
Slope = 0.00466 s(%)= 0.47
TC = k(0.304)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration = 10.049 min.
Rainfall intensity = 2.039(In/Hr) for a 10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.857
Subarea runoff = 0.262(CFS)
Total initial stream area = 0.150(Ac.)
Pervious area fraction = 0.100
Initial area Fm value = 0.098(In/Hr)
End of computations, Total Study Area = 0.15 (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) = 0.100
Area averaged SCS curve number = 32.

APPENDIX B.2: 100 & 10-YEAR STORM EVENT – AREA "B"

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: 03/02/20

BARTON ROAD IMPROVEMENTS
100 YEAR HYDROLOGY ANALYSIS
FILENAME: ARBPR100

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 = 1.080 (In.)
Slope used for rainfall intensity curve b = 0.6000
Soil antecedent moisture condition (AMC) = 2

++

Process from Point/Station 201.000 to Point/Station 202.000
**** INITIAL AREA EVALUATION ****

COMMERCIAL subarea type
Decimal fraction soil group A = 0.840
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.160
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2) = 37.92
Pervious ratio(Ap) = 0.1000 Max loss rate(Fm)= 0.094(In/Hr)
Initial subarea data:
Initial area flow distance = 689.000(Ft.)
Top (of initial area) elevation = 971.000(Ft.)
Bottom (of initial area) elevation = 955.000(Ft.)
Difference in elevation = 16.000(Ft.)
Slope = 0.02322 s(%)= 2.32
TC = k(0.304)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration = 8.810 min.
Rainfall intensity = 3.414(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.875
Subarea runoff = 8.429(CFS)
Total initial stream area = 2.820(Ac.)
Pervious area fraction = 0.100
Initial area Fm value = 0.094(In/Hr)

++

Process from Point/Station 202.000 to Point/Station 203.000
**** IMPROVED CHANNEL TRAVEL TIME ****

Upstream point elevation = 955.000(Ft.)
Downstream point elevation = 953.000(Ft.)

```
Channel length thru subarea  =   342.000(Ft.)
Channel base width      =    5.000(Ft.)
Slope or 'Z' of left channel bank =   4.000
Slope or 'Z' of right channel bank =   4.000
Estimated mean flow rate at midpoint of channel =      8.603(CFS)
Manning's 'N'    = 0.035
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =      8.603(CFS)
Depth of flow =   0.607(Ft.), Average velocity =   1.908(Ft/s)
Channel flow top width =    9.856(Ft.)
Flow Velocity =    1.91(Ft/s)
Travel time  =    2.99 min.
Time of concentration =   11.80 min.
Critical depth =      0.402(Ft.)
 Adding area flow to channel
UNDEVELOPED (poor cover) subarea
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 67.00
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.578(In/Hr)
Rainfall intensity =      2.866(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.837
Subarea runoff =      0.275(CFS) for    0.810(Ac.)
Total runoff =      8.704(CFS)
Effective area this stream =        3.63(Ac.)
Total Study Area (Main Stream No. 1) =        3.63(Ac.)
Area averaged Fm value =    0.202(In/Hr)
Depth of flow =   0.611(Ft.), Average velocity =   1.915(Ft/s)
Critical depth =      0.406(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      203.000 to Point/Station      203.300
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =   953.000(Ft.)
Downstream point/station elevation =   952.800(Ft.)
Pipe length  =   155.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     8.704(CFS)
Nearest computed pipe diameter  =     27.00(In.)
Calculated individual pipe flow  =     8.704(CFS)
Normal flow depth in pipe =   17.98(In.)
Flow top width inside pipe =   25.47(In.)
Critical Depth =   12.17(In.)
Pipe flow velocity =      3.10(Ft/s)
Travel time through pipe =    0.83 min.
Time of concentration (TC) =    12.63 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      203.000 to Point/Station      203.300
**** CONFLUENCE OF MAIN STREAMS ****
________________________________________________________________________
The following data inside Main Stream is listed:
In Main Stream number: 1
Stream flow area =      3.630(Ac.)
Runoff from this stream =      8.704(CFS)
Time of concentration =   12.63 min.
```

```
Rainfall intensity =     2.751(In/Hr)
Area averaged loss rate (Fm) =    0.2017(In/Hr)
Area averaged Pervious ratio (Ap) = 0.3008
Program is now starting with Main Stream No. 2


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      203.100 to Point/Station      203.110
**** INITIAL AREA EVALUATION ****
________________________________________________________________________
COMMERCIAL subarea type
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 32.00
Pervious ratio(Ap) = 0.1000     Max loss rate(Fm)=     0.098(In/Hr)
Initial subarea data:
Initial area flow distance =   565.000(Ft.)
Top (of initial area) elevation =   981.000(Ft.)
Bottom (of initial area) elevation =   971.000(Ft.)
Difference in elevation =    10.000(Ft.)
Slope =    0.01770  s(%)=       1.77
TC = k(0.304)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =    8.592 min.
Rainfall intensity =      3.466(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.875
Subarea runoff =      1.940(CFS)
Total initial stream area =        0.640(Ac.)
Pervious area fraction = 0.100
Initial area Fm value =    0.098(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      203.110 to Point/Station      203.120
**** STREET FLOW TRAVEL TIME + SUBAREA FLOW ADDITION ****
________________________________________________________________________
Top of street segment elevation =   971.000(Ft.)
End of street segment elevation =   963.000(Ft.)
Length of street segment  =   517.000(Ft.)
Height of curb above gutter flowline  =    8.0(In.)
Width of half street (curb to crown)  =  20.000(Ft.)
Distance from crown to crossfall grade break  =  18.000(Ft.)
Slope from gutter to grade break (v/hz) =   0.020
Slope from grade break to crown (v/hz)  =   0.020
Street flow is on [1] side(s) of the street
Distance from curb to property line  =  10.000(Ft.)
Slope from curb to property line (v/hz) =   0.020
Gutter width =   2.000(Ft.)
Gutter hike from flowline =  2.000(In.)
 Manning's N in gutter =  0.0150
 Manning's N from gutter to grade break =  0.0150
 Manning's N from grade break to crown =  0.0150
Estimated mean flow rate at midpoint of street =      2.258(CFS)
Depth of flow =   0.299(Ft.), Average velocity =   2.606(Ft/s)
Streetflow hydraulics at midpoint of street travel:
Halfstreet flow width =   8.601(Ft.)
Flow velocity =   2.61(Ft/s)
Travel time =    3.31 min.     TC =   11.90  min.
 Adding area flow to street
COMMERCIAL subarea type
```

```
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 32.00
Pervious ratio(Ap) = 0.1000     Max loss rate(Fm)=     0.098(In/Hr)
Rainfall intensity =      2.851(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.869
Subarea runoff =      0.563(CFS) for    0.370(Ac.)
Total runoff =      2.503(CFS)
Effective area this stream =        1.01(Ac.)
Total Study Area (Main Stream No. 2) =        4.64(Ac.)
Area averaged Fm value =    0.098(In/Hr)
Street flow at end of street =      2.503(CFS)
Half street flow at end of street =      2.503(CFS)
Depth of flow =   0.307(Ft.), Average velocity =   2.666(Ft/s)
Flow width (from curb towards crown)=   9.011(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      203.120 to Point/Station      203.200
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =   959.000(Ft.)
Downstream point/station elevation =   958.000(Ft.)
Pipe length  =    38.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     2.503(CFS)
Nearest computed pipe diameter  =      9.00(In.)
Calculated individual pipe flow  =     2.503(CFS)
Normal flow depth in pipe =    6.89(In.)
Flow top width inside pipe =    7.62(In.)
Critical Depth =    8.31(In.)
Pipe flow velocity =      6.90(Ft/s)
Travel time through pipe =    0.09 min.
Time of concentration (TC) =    11.99 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      203.100 to Point/Station      203.200
**** CONFLUENCE OF MINOR STREAMS ****
________________________________________________________________________
Along Main Stream number: 2 in normal stream number 1
Stream flow area =      1.010(Ac.)
Runoff from this stream =      2.503(CFS)
Time of concentration =   11.99 min.
Rainfall intensity =     2.838(In/Hr)
Area averaged loss rate (Fm) =    0.0978(In/Hr)
Area averaged Pervious ratio (Ap) = 0.1000


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      102.000 to Point/Station      203.200
**** INITIAL AREA EVALUATION ****
________________________________________________________________________
COMMERCIAL subarea type
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 32.00
```

```
Pervious ratio(Ap) = 0.1000     Max loss rate(Fm)=     0.098(In/Hr)
Initial subarea data:
Initial area flow distance =   512.000(Ft.)
Top (of initial area) elevation =   971.000(Ft.)
Bottom (of initial area) elevation =   963.000(Ft.)
Difference in elevation =     8.000(Ft.)
Slope =    0.01563  s(%)=       1.56
TC = k(0.304)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =    8.469 min.
Rainfall intensity =      3.496(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.875
Subarea runoff =      1.376(CFS)
Total initial stream area =        0.450(Ac.)
Pervious area fraction = 0.100
Initial area Fm value =    0.098(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      102.000 to Point/Station      203.200
**** CONFLUENCE OF MINOR STREAMS ****
________________________________________________________________________
Along Main Stream number: 2 in normal stream number 2
Stream flow area =      0.450(Ac.)
Runoff from this stream =      1.376(CFS)
Time of concentration =    8.47 min.
Rainfall intensity =     3.496(In/Hr)
Area averaged loss rate (Fm) =    0.0978(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      2.50     1.010     11.99    0.098      2.838
2      1.38     0.450      8.47    0.098      3.496
Qmax(1) =
         1.000 *    1.000 *     2.503) +
         0.806 *    1.000 *     1.376) + =       3.613
Qmax(2) =
         1.240 *    0.706 *     2.503) +
         1.000 *    1.000 *     1.376) + =       3.569

Total of 2 streams to confluence:
Flow rates before confluence point:
       2.503       1.376
Maximum flow rates at confluence using above data:
        3.613        3.569
Area of streams before confluence:
        1.010        0.450
Effective area values after confluence:
        1.460        1.163
Results of confluence:
Total flow rate =      3.613(CFS)
Time of concentration =    11.990 min.
Effective stream area after confluence =      1.460(Ac.)
Study area average Pervious fraction(Ap) =  0.100
Study area average soil loss rate(Fm) =    0.098(In/Hr)
Study area total (this main stream) =       1.46(Ac.)
```

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      203.200 to Point/Station      203.300
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
------------------------------------------------------------------------
Upstream point/station elevation =   958.000(Ft.)
Downstream point/station elevation =   952.800(Ft.)
Pipe length  =    85.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     3.613(CFS)
Nearest computed pipe diameter  =      9.00(In.)
Calculated individual pipe flow  =     3.613(CFS)
Normal flow depth in pipe =    6.57(In.)
Flow top width inside pipe =    7.99(In.)
Critical depth could not be calculated.
Pipe flow velocity =     10.46(Ft/s)
Travel time through pipe =    0.14 min.
Time of concentration (TC) =    12.13 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      203.200 to Point/Station      203.300
**** CONFLUENCE OF MAIN STREAMS ****
------------------------------------------------------------------------
The following data inside Main Stream is listed:
In Main Stream number: 2
Stream flow area =      1.460(Ac.)
Runoff from this stream =      3.613(CFS)
Time of concentration =   12.13 min.
Rainfall intensity =     2.819(In/Hr)
Area averaged loss rate (Fm) =    0.0978(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      8.70     3.630     12.63    0.202      2.751
2      3.61     1.460     12.13    0.098      2.819
Qmax(1) =
         1.000 *    1.000 *     8.704) +
         0.975 *    1.000 *     3.613) + =      12.226
Qmax(2) =
         1.027 *    0.960 *     8.704) +
         1.000 *    1.000 *     3.613) + =      12.192

Total of 2 main streams to confluence:
Flow rates before confluence point:
       9.704       4.613
Maximum flow rates at confluence using above data:
       12.226       12.192
Area of streams before confluence:
        3.630        1.460
Effective area values after confluence:
        5.090        4.945


Results of confluence:
Total flow rate =     12.226(CFS)
Time of concentration =    12.632 min.
Effective stream area after confluence  =      5.090(Ac.)
Study area average Pervious fraction(Ap) =  0.243
```

```
Study area average soil loss rate(Fm) =    0.172(In/Hr)
Study area total =       5.09(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      203.300 to Point/Station      204.000
**** IMPROVED CHANNEL TRAVEL TIME ****
________________________________________________________________________
Upstream point elevation =   952.800(Ft.)
Downstream point elevation =   952.000(Ft.)
Channel length thru subarea  =   362.000(Ft.)
Channel base width      =    5.000(Ft.)
Slope or 'Z' of left channel bank =   4.000
Slope or 'Z' of right channel bank =   4.000
Estimated mean flow rate at midpoint of channel =     12.254(CFS)
Manning's 'N'    = 0.035
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =     12.254(CFS)
Depth of flow =   0.939(Ft.), Average velocity =   1.490(Ft/s)
Channel flow top width =   12.512(Ft.)
Flow Velocity =    1.49(Ft/s)
Travel time  =    4.05 min.
Time of concentration =   16.68 min.
Critical depth =      0.496(Ft.)
 Adding area flow to channel
UNDEVELOPED (poor cover) subarea
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 67.00
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.578(In/Hr)
The area added to the existing stream causes a
a lower flow rate of Q =     12.192(CFS)
therefore the upstream flow rate of Q =     12.226(CFS) is being used
Rainfall intensity =      2.328(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.798
Subarea runoff =      0.000(CFS) for    1.470(Ac.)
Total runoff =     12.226(CFS)
Effective area this stream =        6.56(Ac.)
Total Study Area (Main Stream No. 1) =        6.56(Ac.)
Area averaged Fm value =    0.263(In/Hr)
Depth of flow =   0.938(Ft.), Average velocity =   1.489(Ft/s)
Critical depth =      0.496(Ft.)
End of computations, Total Study Area =            6.56 (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) = 0.413
Area averaged SCS curve number =  46.7
```

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: 03/02/20

BARTON ROAD IMPROVEMENTS
10 YEAR HYDROLOGY ANALYSIS
FILENAME: ARBPR10

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 = 0.698 (In.)
Slope used for rainfall intensity curve b = 0.6000
Soil antecedent moisture condition (AMC) = 2

++

Process from Point/Station 201.000 to Point/Station 202.000
**** INITIAL AREA EVALUATION ****

COMMERCIAL subarea type
Decimal fraction soil group A = 0.840
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.160
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2) = 37.92
Pervious ratio(Ap) = 0.1000 Max loss rate(Fm)= 0.094(In/Hr)
Initial subarea data:
Initial area flow distance = 689.000(Ft.)
Top (of initial area) elevation = 971.000(Ft.)
Bottom (of initial area) elevation = 955.000(Ft.)
Difference in elevation = 16.000(Ft.)
Slope = 0.02322 s(%)= 2.32
TC = k(0.304)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration = 8.810 min.
Rainfall intensity = 2.207(In/Hr) for a 10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.862
Subarea runoff = 5.363(CFS)
Total initial stream area = 2.820(Ac.)
Pervious area fraction = 0.100
Initial area Fm value = 0.094(In/Hr)

++

Process from Point/Station 202.000 to Point/Station 203.000
**** IMPROVED CHANNEL TRAVEL TIME ****

```
Upstream point elevation =   955.000(Ft.)
Downstream point elevation =   953.000(Ft.)
Channel length thru subarea  =   342.000(Ft.)
Channel base width      =    5.000(Ft.)
Slope or 'Z' of left channel bank =   4.000
Slope or 'Z' of right channel bank =   4.000
Estimated mean flow rate at midpoint of channel =      5.412(CFS)
Manning's 'N'    = 0.035
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =      5.412(CFS)
Depth of flow =   0.473(Ft.), Average velocity =   1.661(Ft/s)
Channel flow top width =    8.781(Ft.)
Flow Velocity =    1.66(Ft/s)
Travel time  =    3.43 min.
Time of concentration =   12.24 min.
Critical depth =      0.305(Ft.)
 Adding area flow to channel
UNDEVELOPED (poor cover) subarea
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 67.00
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.578(In/Hr)
The area added to the existing stream causes a
a lower flow rate of Q =      5.260(CFS)
therefore the upstream flow rate of Q =      5.363(CFS) is being used
Rainfall intensity =      1.812(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.800
Subarea runoff =      0.000(CFS) for    0.810(Ac.)
Total runoff =      5.363(CFS)
Effective area this stream =        3.63(Ac.)
Total Study Area (Main Stream No. 1) =        3.63(Ac.)
Area averaged Fm value =    0.202(In/Hr)
Depth of flow =   0.470(Ft.), Average velocity =   1.657(Ft/s)
Critical depth =      0.301(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      203.000 to Point/Station      203.300
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
------------------------------------------------------------------------
Upstream point/station elevation =   953.000(Ft.)
Downstream point/station elevation =   952.800(Ft.)
Pipe length  =   155.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     5.363(CFS)
Nearest computed pipe diameter  =     21.00(In.)
Calculated individual pipe flow  =     5.363(CFS)
Normal flow depth in pipe =   16.22(In.)
Flow top width inside pipe =   17.61(In.)
Critical Depth =   10.22(In.)
Pipe flow velocity =      2.69(Ft/s)
Travel time through pipe =    0.96 min.
Time of concentration (TC) =    13.20 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      203.000 to Point/Station      203.300
```

```
**** CONFLUENCE OF MAIN STREAMS ****
--------------------------------------------------------------------------------
The following data inside Main Stream is listed:
In Main Stream number: 1
Stream flow area =      3.630(Ac.)
Runoff from this stream =      5.363(CFS)
Time of concentration =   13.20 min.
Rainfall intensity =     1.731(In/Hr)
Area averaged loss rate (Fm) =    0.2017(In/Hr)
Area averaged Pervious ratio (Ap) = 0.3008
Program is now starting with Main Stream No. 2


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      203.100 to Point/Station      203.110
**** INITIAL AREA EVALUATION ****
--------------------------------------------------------------------------------
COMMERCIAL subarea type
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 32.00
Pervious ratio(Ap) = 0.1000     Max loss rate(Fm)=     0.098(In/Hr)
Initial subarea data:
Initial area flow distance =   565.000(Ft.)
Top (of initial area) elevation =   981.000(Ft.)
Bottom (of initial area) elevation =   971.000(Ft.)
Difference in elevation =    10.000(Ft.)
Slope =    0.01770  s(%)=       1.77
TC = k(0.304)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =    8.592 min.
Rainfall intensity =      2.240(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.861
Subarea runoff =      1.234(CFS)
Total initial stream area =        0.640(Ac.)
Pervious area fraction = 0.100
Initial area Fm value =    0.098(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      203.110 to Point/Station      203.120
**** STREET FLOW TRAVEL TIME + SUBAREA FLOW ADDITION ****
--------------------------------------------------------------------------------
Top of street segment elevation =   971.000(Ft.)
End of street segment elevation =   963.000(Ft.)
Length of street segment  =   517.000(Ft.)
Height of curb above gutter flowline  =    8.0(In.)
Width of half street (curb to crown)  =  20.000(Ft.)
Distance from crown to crossfall grade break  =  18.000(Ft.)
Slope from gutter to grade break (v/hz) =   0.020
Slope from grade break to crown (v/hz)  =   0.020
Street flow is on [1] side(s) of the street
Distance from curb to property line  =  10.000(Ft.)
Slope from curb to property line (v/hz) =   0.020
Gutter width =   2.000(Ft.)
Gutter hike from flowline =  2.000(In.)
 Manning's N in gutter =  0.0150
 Manning's N from gutter to grade break =  0.0150
```

```
 Manning's N from grade break to crown =  0.0150
Estimated mean flow rate at midpoint of street =      1.446(CFS)
Depth of flow =   0.266(Ft.), Average velocity =   2.371(Ft/s)
Streetflow hydraulics at midpoint of street travel:
Halfstreet flow width =   6.952(Ft.)
Flow velocity =   2.37(Ft/s)
Travel time =    3.63 min.     TC =   12.23  min.
 Adding area flow to street
COMMERCIAL subarea type
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 32.00
Pervious ratio(Ap) = 0.1000     Max loss rate(Fm)=     0.098(In/Hr)
Rainfall intensity =      1.813(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.851
Subarea runoff =      0.325(CFS) for    0.370(Ac.)
Total runoff =      1.559(CFS)
Effective area this stream =        1.01(Ac.)
Total Study Area (Main Stream No. 2) =        4.64(Ac.)
Area averaged Fm value =    0.098(In/Hr)
Street flow at end of street =      1.559(CFS)
Half street flow at end of street =      1.559(CFS)
Depth of flow =   0.271(Ft.), Average velocity =   2.408(Ft/s)
Flow width (from curb towards crown)=   7.216(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      203.120 to Point/Station      203.200
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =   959.000(Ft.)
Downstream point/station elevation =   958.000(Ft.)
Pipe length  =    38.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     1.559(CFS)
Nearest computed pipe diameter  =      9.00(In.)
Calculated individual pipe flow  =     1.559(CFS)
Normal flow depth in pipe =    4.93(In.)
Flow top width inside pipe =    8.96(In.)
Critical Depth =    6.90(In.)
Pipe flow velocity =      6.30(Ft/s)
Travel time through pipe =    0.10 min.
Time of concentration (TC) =    12.33 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      203.100 to Point/Station      203.200
**** CONFLUENCE OF MINOR STREAMS ****
________________________________________________________________________
Along Main Stream number: 2 in normal stream number 1
Stream flow area =      1.010(Ac.)
Runoff from this stream =      1.559(CFS)
Time of concentration =   12.33 min.
Rainfall intensity =     1.804(In/Hr)
Area averaged loss rate (Fm) =    0.0978(In/Hr)
Area averaged Pervious ratio (Ap) = 0.1000
```

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      102.000 to Point/Station      203.200
**** INITIAL AREA EVALUATION ****
------------------------------------------------------------------------
COMMERCIAL subarea type
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 32.00
Pervious ratio(Ap) = 0.1000     Max loss rate(Fm)=     0.098(In/Hr)
Initial subarea data:
Initial area flow distance =   512.000(Ft.)
Top (of initial area) elevation =   971.000(Ft.)
Bottom (of initial area) elevation =   963.000(Ft.)
Difference in elevation =     8.000(Ft.)
Slope =    0.01563  s(%)=       1.56
TC = k(0.304)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =    8.469 min.
Rainfall intensity =      2.260(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.861
Subarea runoff =      0.876(CFS)
Total initial stream area =        0.450(Ac.)
Pervious area fraction = 0.100
Initial area Fm value =    0.098(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      102.000 to Point/Station      203.200
**** CONFLUENCE OF MINOR STREAMS ****
------------------------------------------------------------------------
Along Main Stream number: 2 in normal stream number 2
Stream flow area =      0.450(Ac.)
Runoff from this stream =      0.876(CFS)
Time of concentration =    8.47 min.
Rainfall intensity =     2.260(In/Hr)
Area averaged loss rate (Fm) =    0.0978(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      1.56     1.010     12.33    0.098      1.804
2      0.88     0.450      8.47    0.098      2.260
Qmax(1) =
         1.000 *    1.000 *     1.559) +
         0.789 *    1.000 *     0.876) + =       2.250
Qmax(2) =
         1.267 *    0.687 *     1.559) +
         1.000 *    1.000 *     0.876) + =       2.233

Total of 2 streams to confluence:
Flow rates before confluence point:
       1.559       0.876
Maximum flow rates at confluence using above data:
        2.250        2.233
```

```
Area of streams before confluence:
        1.010        0.450
Effective area values after confluence:
        1.460        1.144
Results of confluence:
Total flow rate =      2.250(CFS)
Time of concentration =    12.326 min.
Effective stream area after confluence =      1.460(Ac.)
Study area average Pervious fraction(Ap) =  0.100
Study area average soil loss rate(Fm) =    0.098(In/Hr)
Study area total (this main stream) =       1.46(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      203.200 to Point/Station      203.300
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________________
Upstream point/station elevation =   958.000(Ft.)
Downstream point/station elevation =   952.800(Ft.)
Pipe length  =    85.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     2.250(CFS)
Nearest computed pipe diameter  =      9.00(In.)
Calculated individual pipe flow  =     2.250(CFS)
Normal flow depth in pipe =    4.76(In.)
Flow top width inside pipe =    8.98(In.)
Critical Depth =    8.05(In.)
Pipe flow velocity =      9.48(Ft/s)
Travel time through pipe =    0.15 min.
Time of concentration (TC) =    12.48 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      203.200 to Point/Station      203.300
**** CONFLUENCE OF MAIN STREAMS ****
______________________________________________________________________________
The following data inside Main Stream is listed:
In Main Stream number: 2
Stream flow area =      1.460(Ac.)
Runoff from this stream =      2.250(CFS)
Time of concentration =   12.48 min.
Rainfall intensity =     1.791(In/Hr)
Area averaged loss rate (Fm) =    0.0978(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      5.36     3.630     13.20    0.202      1.731
2      2.25     1.460     12.48    0.098      1.791
Qmax(1) =
         1.000 *    1.000 *     5.363) +
         0.965 *    1.000 *     2.250) + =       7.534
Qmax(2) =
         1.039 *    0.945 *     5.363) +
         1.000 *    1.000 *     2.250) + =       7.517

Total of 2 main streams to confluence:
```

```
Flow rates before confluence point:
       6.363       3.250
Maximum flow rates at confluence using above data:
        7.534        7.517
Area of streams before confluence:
        3.630        1.460
Effective area values after confluence:
        5.090        4.891


Results of confluence:
Total flow rate =      7.534(CFS)
Time of concentration =    13.201 min.
Effective stream area after confluence  =      5.090(Ac.)
Study area average Pervious fraction(Ap) =  0.243
Study area average soil loss rate(Fm) =    0.172(In/Hr)
Study area total =       5.09(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      203.300 to Point/Station      204.000
**** IMPROVED CHANNEL TRAVEL TIME ****
________________________________________________________________________
Upstream point elevation =   952.800(Ft.)
Downstream point elevation =   952.000(Ft.)
Channel length thru subarea  =   362.000(Ft.)
Channel base width      =    5.000(Ft.)
Slope or 'Z' of left channel bank =   4.000
Slope or 'Z' of right channel bank =   4.000
Estimated mean flow rate at midpoint of channel =      7.568(CFS)
Manning's 'N'    = 0.035
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =      7.568(CFS)
Depth of flow =   0.733(Ft.), Average velocity =   1.301(Ft/s)
Channel flow top width =   10.865(Ft.)
Flow Velocity =    1.30(Ft/s)
Travel time  =    4.64 min.
Time of concentration =   17.84 min.
Critical depth =      0.375(Ft.)
 Adding area flow to channel
UNDEVELOPED (poor cover) subarea
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 67.00
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.578(In/Hr)
The area added to the existing stream causes a
a lower flow rate of Q =      6.980(CFS)
therefore the upstream flow rate of Q =      7.534(CFS) is being used
Rainfall intensity =      1.445(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.736
Subarea runoff =      0.000(CFS) for    1.470(Ac.)
Total runoff =      7.534(CFS)
Effective area this stream =        6.56(Ac.)
Total Study Area (Main Stream No. 1) =        6.56(Ac.)
Area averaged Fm value =    0.263(In/Hr)
Depth of flow =   0.731(Ft.), Average velocity =   1.300(Ft/s)
```

Critical depth = 0.371(Ft.)
End of computations, Total Study Area = 6.56 (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) = 0.413
Area averaged SCS curve number = 46.7

APPENDIX B.3: 100 & 10-YEAR STORM EVENT – AREA "C"

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: 01/14/20

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 = 1.080 (In.)
Slope used for rainfall intensity curve b = 0.6000
Soil antecedent moisture condition (AMC) = 2

++
Process from Point/Station 301.000 to Point/Station 302.000
**** INITIAL AREA EVALUATION ****

COMMERCIAL subarea type
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2) = 32.00
Pervious ratio(Ap) = 0.1000 Max loss rate(Fm)= 0.098(In/Hr)
Initial subarea data:
Initial area flow distance = 553.000(Ft.)
Top (of initial area) elevation = 963.500(Ft.)
Bottom (of initial area) elevation = 953.000(Ft.)
Difference in elevation = 10.500(Ft.)
Slope = 0.01899 s(%)= 1.90
TC = k(0.304)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration = 8.400 min.
Rainfall intensity = 3.514(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.875
Subarea runoff = 1.230(CFS)
Total initial stream area = 0.400(Ac.)
Pervious area fraction = 0.100
Initial area Fm value = 0.098(In/Hr)
End of computations, Total Study Area = 0.40 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.
Note: These figures do not consider reduced effective area
effects caused by confluences in the rational equation.

Area averaged pervious area fraction(Ap) = 0.100
Area averaged SCS curve number = 32.0

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: 01/14/20

BARTON ROAD IMPROVEMENTS
10 YEAR HYDROLOGY ANALYSIS
FILENAME: ARCPR10

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 = 0.698 (In.)
Slope used for rainfall intensity curve b = 0.6000
Soil antecedent moisture condition (AMC) = 2

++
Process from Point/Station 301.000 to Point/Station 302.000
**** INITIAL AREA EVALUATION ****

COMMERCIAL subarea type
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2) = 32.00
Pervious ratio(Ap) = 0.1000 Max loss rate(Fm)= 0.098(In/Hr)
Initial subarea data:
Initial area flow distance = 553.000(Ft.)
Top (of initial area) elevation = 963.500(Ft.)
Bottom (of initial area) elevation = 953.000(Ft.)
Difference in elevation = 10.500(Ft.)
Slope = 0.01899 s(%)= 1.90
TC = k(0.304)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration = 8.400 min.
Rainfall intensity = 2.271(In/Hr) for a 10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.861
Subarea runoff = 0.782(CFS)
Total initial stream area = 0.400(Ac.)
Pervious area fraction = 0.100
Initial area Fm value = 0.098(In/Hr)
End of computations, Total Study Area = 0.40 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.
Note: These figures do not consider reduced effective area
effects caused by confluences in the rational equation.

Area averaged pervious area fraction(Ap) = 0.100
Area averaged SCS curve number = 32.0

APPENDIX B.4: 100 & 10-YEAR STORM EVENT – AREA "D"

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: 01/14/20

BARTON ROAD IMPROVEMENTS
100 YEAR HYDROLOGY ANALYSIS
FILENAME: ARDPR100

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 = 1.080 (In.)
Slope used for rainfall intensity curve b = 0.6000
Soil antecedent moisture condition (AMC) = 2

++
Process from Point/Station 401.000 to Point/Station 402.000
**** INITIAL AREA EVALUATION ****

COMMERCIAL subarea type
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2) = 32.00
Pervious ratio(Ap) = 0.1000 Max loss rate(Fm)= 0.098(In/Hr)
Initial subarea data:
Initial area flow distance = 567.000(Ft.)
Top (of initial area) elevation = 963.500(Ft.)
Bottom (of initial area) elevation = 953.000(Ft.)
Difference in elevation = 10.500(Ft.)
Slope = 0.01852 s(%)= 1.85
TC = k(0.304)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration = 8.527 min.
Rainfall intensity = 3.482(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.875
Subarea runoff = 1.218(CFS)
Total initial stream area = 0.400(Ac.)
Pervious area fraction = 0.100
Initial area Fm value = 0.098(In/Hr)
End of computations, Total Study Area = 0.40 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.
Note: These figures do not consider reduced effective area
effects caused by confluences in the rational equation.

Area averaged pervious area fraction(Ap) = 0.100
Area averaged SCS curve number = 32.0

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: 01/14/20

BARTON ROAD IMPROVEMENTS
10 YEAR HYDROLOGY ANALYSIS
FILENAME: ARDPR10

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 = 0.698 (In.)
Slope used for rainfall intensity curve b = 0.6000
Soil antecedent moisture condition (AMC) = 2

++
Process from Point/Station 401.000 to Point/Station 402.000
**** INITIAL AREA EVALUATION ****

COMMERCIAL subarea type
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2) = 32.00
Pervious ratio(Ap) = 0.1000 Max loss rate(Fm)= 0.098(In/Hr)
Initial subarea data:
Initial area flow distance = 567.000(Ft.)
Top (of initial area) elevation = 963.500(Ft.)
Bottom (of initial area) elevation = 953.000(Ft.)
Difference in elevation = 10.500(Ft.)
Slope = 0.01852 s(%)= 1.85
TC = k(0.304)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration = 8.527 min.
Rainfall intensity = 2.250(In/Hr) for a 10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.861
Subarea runoff = 0.775(CFS)
Total initial stream area = 0.400(Ac.)
Pervious area fraction = 0.100
Initial area Fm value = 0.098(In/Hr)
End of computations, Total Study Area = 0.40 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.
Note: These figures do not consider reduced effective area
effects caused by confluences in the rational equation.

Area averaged pervious area fraction(Ap) = 0.100
Area averaged SCS curve number = 32.0

APPENDIX C: STORM DRAIN HYDRAULIC ANALYSES

APPENDIX C.1: BARTON ROAD 30-INCH CULVERT

Worksheet for Barton Road 30-Inch Culvert Reach #1

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00500	ft/ft
Diameter	2.50	ft
Discharge	8.70	ft³/s

Results

Normal Depth	0.94	ft
Flow Area	1.68	ft²
Wetted Perimeter	3.30	ft
Hydraulic Radius	0.51	ft
Top Width	2.42	ft
Critical Depth	0.98	ft
Percent Full	37.6	%
Critical Slope	0.00423	ft/ft
Velocity	5.16	ft/s
Velocity Head	0.41	ft
Specific Energy	1.35	ft
Froude Number	1.09	
Maximum Discharge	31.20	ft³/s
Discharge Full	29.00	ft³/s
Slope Full	0.00045	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	37.55	%
Downstream Velocity	Infinity	ft/s

Worksheet for Barton Road 30-Inch Culvert Reach #1

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.94	ft
Critical Depth	0.98	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.00423	ft/ft

Messages

Notes

Flows tributary to the Upstream Entrance of Pipe
Q100 = 8.6 cfs

Worksheet for Barton Road 30-Inch Culvert Reach #2

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00500	ft/ft
Diameter	2.50	ft
Discharge	12.20	ft³/s

Results

Normal Depth	1.13	ft
Flow Area	2.16	ft²
Wetted Perimeter	3.69	ft
Hydraulic Radius	0.58	ft
Top Width	2.49	ft
Critical Depth	1.17	ft
Percent Full	45.3	%
Critical Slope	0.00441	ft/ft
Velocity	5.65	ft/s
Velocity Head	0.50	ft
Specific Energy	1.63	ft
Froude Number	1.07	
Maximum Discharge	31.20	ft³/s
Discharge Full	29.00	ft³/s
Slope Full	0.00088	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	45.25	%
Downstream Velocity	Infinity	ft/s

Worksheet for Barton Road 30-Inch Culvert Reach #2

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	1.13	ft
Critical Depth	1.17	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.00441	ft/ft

Messages

Notes

Barton Rd Culvert w/ 18" Lateral
Flows tributary to the Upstream Entrance of Pipe
and Area A
Q100 = 11.2 cfs

APPENDIX C.2: BARTON ROAD STORM DRAIN LINE 1

Worksheet for Proposed 18" Connector Pipe Reach #1

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00500	ft/ft
Diameter	1.50	ft
Discharge	2.50	ft³/s

Results

Normal Depth	0.60	ft
Flow Area	0.66	ft²
Wetted Perimeter	2.05	ft
Hydraulic Radius	0.32	ft
Top Width	1.47	ft
Critical Depth	0.60	ft
Percent Full	40.0	%
Critical Slope	0.00503	ft/ft
Velocity	3.79	ft/s
Velocity Head	0.22	ft
Specific Energy	0.82	ft
Froude Number	1.00	
Maximum Discharge	7.99	ft³/s
Discharge Full	7.43	ft³/s
Slope Full	0.00057	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	39.97	%
Downstream Velocity	Infinity	ft/s

Worksheet for Proposed 18" Connector Pipe Reach #1

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.60	ft
Critical Depth	0.60	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.00503	ft/ft

Messages

Notes

Flows Tributary to South Side of Barton Road
Q100=1.3 cfs

Worksheet for Proposed 18" Connector Pipe Reach #2

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00500	ft/ft
Diameter	1.50	ft
Discharge	3.60	ft^3/s

Results

Normal Depth	0.74	ft
Flow Area	0.86	ft^2
Wetted Perimeter	2.33	ft
Hydraulic Radius	0.37	ft
Top Width	1.50	ft
Critical Depth	0.72	ft
Percent Full	49.1	%
Critical Slope	0.00529	ft/ft
Velocity	4.17	ft/s
Velocity Head	0.27	ft
Specific Energy	1.01	ft
Froude Number	0.97	
Maximum Discharge	7.99	ft^3/s
Discharge Full	7.43	ft^3/s
Slope Full	0.00117	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	49.08	%
Downstream Velocity	Infinity	ft/s

Worksheet for Proposed 18" Connector Pipe Reach #2

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.74	ft
Critical Depth	0.72	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.00529	ft/ft

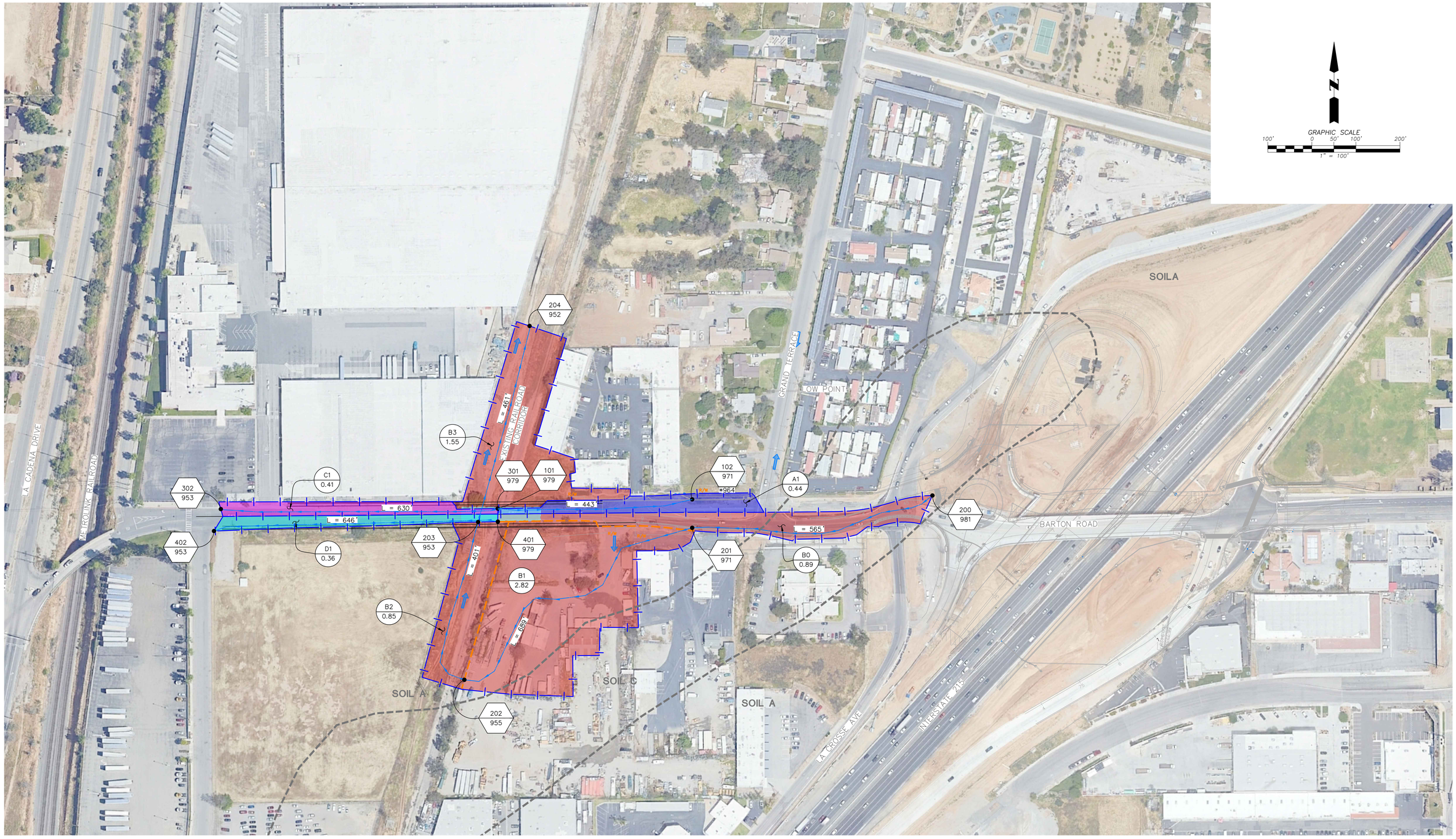
Messages

Notes

Flows Tributary to South Side and North Side of Barton Road
Q100=2.7 cfs

EXHIBITS

EXHIBIT A: PRE-PROJECT HYDROLOGY MAP



LEGEND:

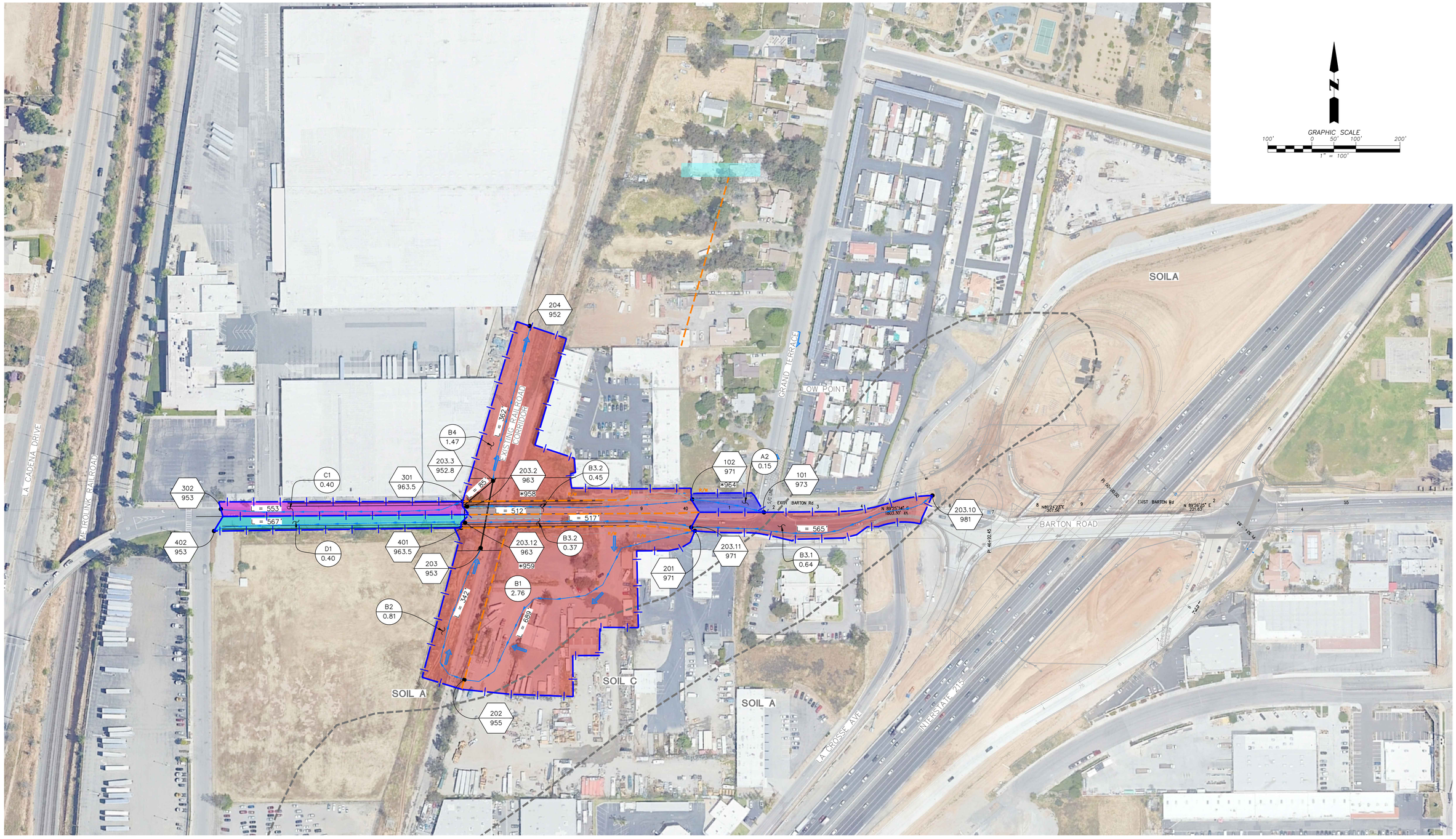
X.X / X.X — NODE/CONCENTRATION POINT, FLOWLINE ELEVATION	WATERSHED MAIN BOUNDARY
*XXXX — APPROXIMATE INVERT ELEVATION	WATERSHED SUB-BOUNDARY
XXX / X.X — SUB AREA, ACRES	FLOW PATH
L=XXX' — FLOW DISTANCE	AREA A, AREA B, AREA C, AREA D

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

WEST BARTON ROAD IMPROVEMENTS

EXHIBIT A
PRE-PROJECT HYDROLOGY MAP

EXHIBIT B: POST-PROJECT HYDROLOGY MAP



LEGEND:

X.X / X.X — NODE/CONCENTRATION POINT, FLOWLINE ELEVATION	WATERSHED MAIN BOUNDARY
*XXXX — APPROXIMATE INVERT ELEVATION	WATERSHED SUB-BOUNDARY
XXX / X.X — SUB AREA, ACRES	FLOW PATH
L=XXX' — FLOW DISTANCE	AREA A, AREA B, AREA C, AREA D

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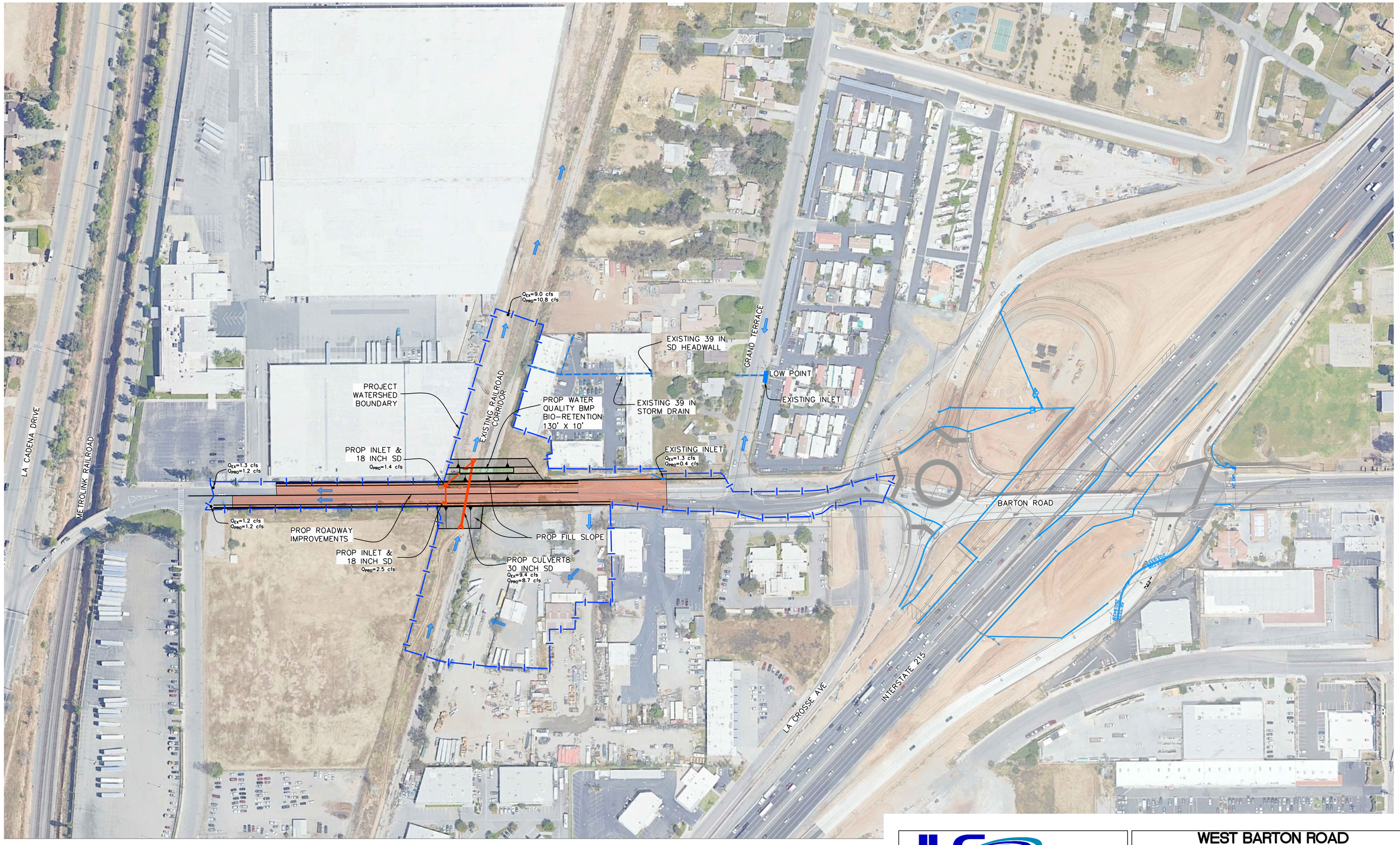
WEST BARTON ROAD IMPROVEMENTS

EXHIBIT B
HYDROLOGY MAP

EXHIBIT C: DRAINAGE FACILITIES MAP



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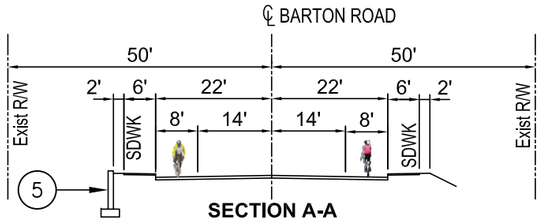
WEST BARTON ROAD IMPROVEMENTS

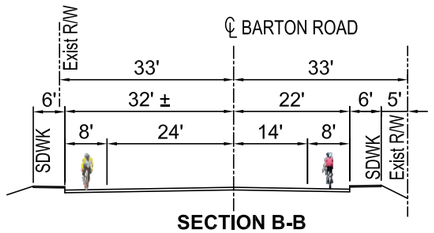
EXHIBIT C
DRAINAGE FACILITIES MAP

EXCERPTS

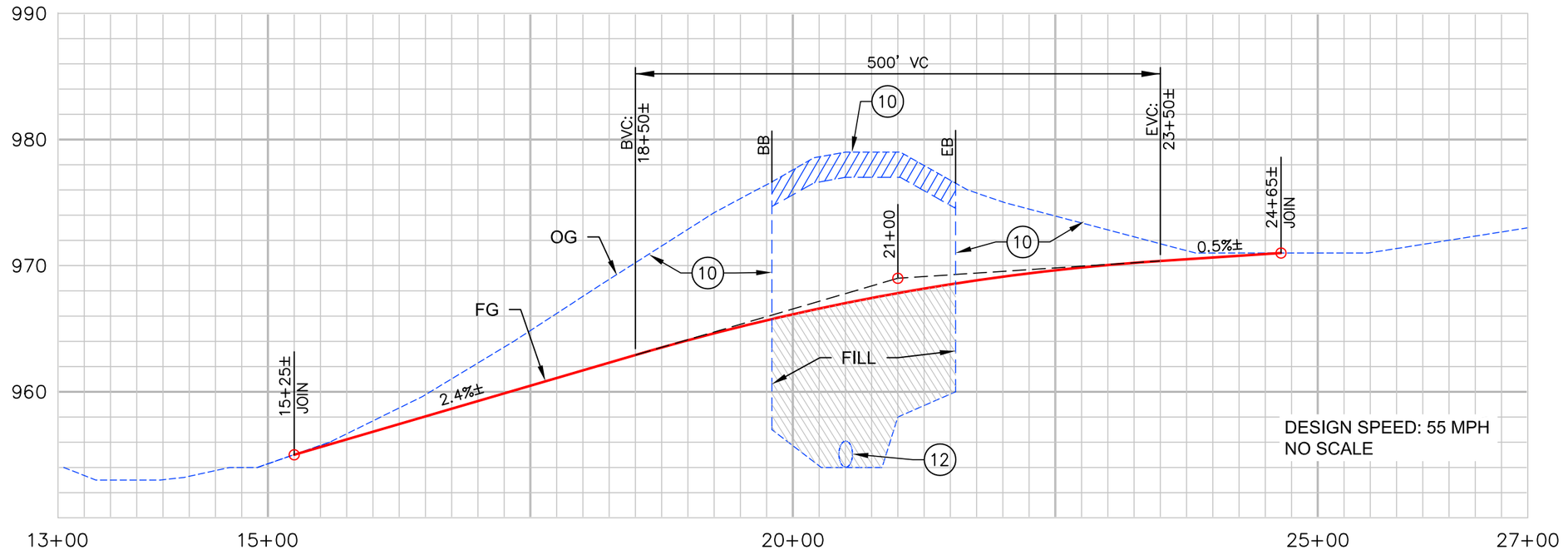
EXCERPT 1: BARTON ROAD CONCEPTUAL DESIGN



SECTION A-A

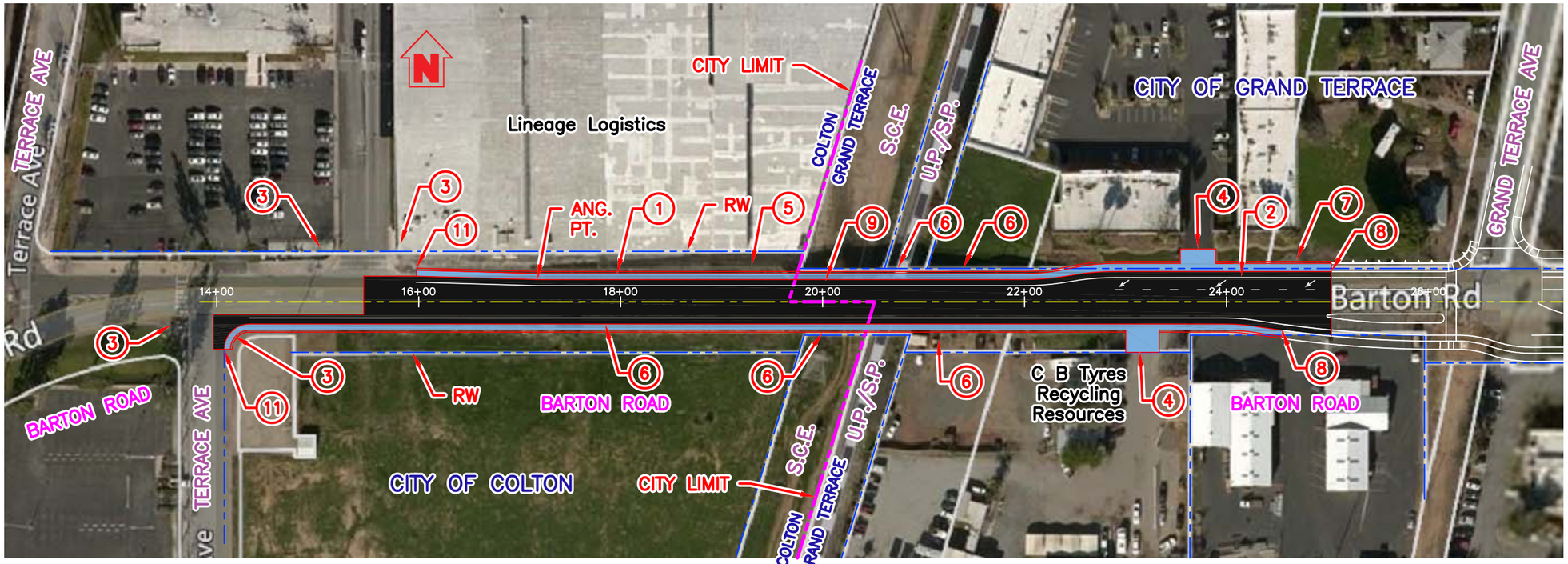


SECTION B-B



LEGEND:

1. New Roadway Section Per Section A-A
2. New Roadway Section per Section B-B
3. Reconstruct Curb Ramp to ADA Standards
4. Reconstruct Driveway per City of Grand Terrace Standards
5. Reconstruct Retaining Wall
6. Grade Max Slope 2:1
7. Remove or Reconstruct Drainage Inlet
8. Join Barton Road Interchange Street Improvements
9. Relocate RHWCO Waterline and Gas Line currently in Bridge
10. Remove Bridge, Retaining walls, and abutments
11. Join Existing
12. Provide Drainage Culvert



0' 100' 200' 300' 400'

ROAD PLAN

BARTON ROAD IMPROVEMENTS

CNS Engineers

EXCERPT 2: NOAA ATLAS 14 RAINFALL VALUES

NOAA Atlas 14, Volume 6, Version 2
Location name: Grand Terrace, California, USA*
Latitude: 34.034°, Longitude: -117.328°
Elevation: 966.68 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/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**1.10** (0.924-1.34)	**1.42** (1.18-1.72)	**1.82** (1.51-2.22)	**2.16** (1.78-2.65)	**2.62** (2.08-3.32)	**2.98** (2.32-3.86)	**3.35** (2.53-4.45)	**3.73** (2.75-5.11)	**4.26** (3.00-6.10)	**4.68** (3.18-6.94)
10-min	**0.798** (0.660-0.966)	**1.01** (0.846-1.23)	**1.31** (1.09-1.59)	**1.55** (1.27-1.90)	**1.88** (1.49-2.38)	**2.13** (1.66-2.77)	**2.39** (1.82-3.19)	**2.67** (1.97-3.67)	**3.05** (2.15-4.37)	**3.35** (2.28-4.97)
15-min	**0.640** (0.536-0.776)	**0.816** (0.680-0.992)	**1.05** (0.872-1.28)	**1.24** (1.02-1.53)	**1.51** (1.20-1.92)	**1.72** (1.34-2.23)	**1.93** (1.46-2.57)	**2.16** (1.59-2.95)	**2.46** (1.74-3.52)	**2.70** (1.84-4.00)
30-min	**0.490** (0.408-0.594)	**0.624** (0.520-0.758)	**0.804** (0.666-0.978)	**0.950** (0.782-1.17)	**1.15** (0.918-1.47)	**1.31** (1.02-1.70)	**1.47** (1.12-1.96)	**1.64** (1.21-2.25)	**1.88** (1.33-2.69)	**2.06** (1.40-3.06)
60-min	**0.359** (0.299-0.435)	**0.458** (0.381-0.556)	**0.590** (0.489-0.718)	**0.698** (0.574-0.857)	**0.847** (0.673-1.08)	**0.963** (0.749-1.25)	**1.08** (0.821-1.44)	**1.21** (0.889-1.65)	**1.38** (0.973-1.97)	**1.51** (1.03-2.24)
2-hr	**0.254** (0.212-0.308)	**0.324** (0.270-0.394)	**0.417** (0.346-0.508)	**0.494** (0.406-0.606)	**0.598** (0.476-0.760)	**0.680** (0.529-0.882)	**0.764** (0.579-1.02)	**0.850** (0.627-1.17)	**0.970** (0.685-1.39)	**1.06** (0.726-1.58)
3-hr	**0.208** (0.173-0.252)	**0.265** (0.221-0.322)	**0.341** (0.283-0.415)	**0.403** (0.332-0.495)	**0.489** (0.389-0.621)	**0.555** (0.432-0.721)	**0.623** (0.473-0.830)	**0.694** (0.512-0.952)	**0.792** (0.559-1.13)	**0.868** (0.592-1.29)
6-hr	**0.146** (0.122-0.177)	**0.187** (0.155-0.226)	**0.240** (0.199-0.292)	**0.283** (0.233-0.348)	**0.343** (0.273-0.436)	**0.389** (0.303-0.506)	**0.437** (0.331-0.581)	**0.486** (0.358-0.666)	**0.553** (0.390-0.791)	**0.605** (0.412-0.897)
12-hr	**0.096** (0.080-0.117)	**0.123** (0.103-0.149)	**0.158** (0.131-0.193)	**0.187** (0.154-0.229)	**0.226** (0.180-0.287)	**0.256** (0.199-0.332)	**0.287** (0.217-0.381)	**0.318** (0.234-0.436)	**0.361** (0.255-0.516)	**0.394** (0.269-0.584)
24-hr	**0.064** (0.057-0.074)	**0.083** (0.073-0.095)	**0.107** (0.094-0.123)	**0.126** (0.110-0.147)	**0.152** (0.129-0.183)	**0.172** (0.143-0.212)	**0.192** (0.156-0.242)	**0.213** (0.168-0.276)	**0.241** (0.182-0.325)	**0.263** (0.192-0.367)
2-day	**0.039** (0.035-0.045)	**0.051** (0.045-0.059)	**0.067** (0.059-0.077)	**0.079** (0.069-0.092)	**0.096** (0.082-0.116)	**0.110** (0.091-0.135)	**0.123** (0.100-0.155)	**0.137** (0.108-0.178)	**0.156** (0.118-0.210)	**0.171** (0.125-0.238)
3-day	**0.028** (0.025-0.032)	**0.037** (0.033-0.043)	**0.049** (0.043-0.057)	**0.059** (0.051-0.069)	**0.072** (0.061-0.087)	**0.083** (0.069-0.102)	**0.094** (0.076-0.118)	**0.105** (0.083-0.136)	**0.120** (0.091-0.162)	**0.132** (0.097-0.185)
4-day	**0.022** (0.020-0.026)	**0.030** (0.027-0.035)	**0.040** (0.035-0.046)	**0.048** (0.042-0.056)	**0.060** (0.051-0.072)	**0.069** (0.057-0.085)	**0.078** (0.063-0.098)	**0.088** (0.069-0.114)	**0.101** (0.077-0.136)	**0.112** (0.082-0.156)
7-day	**0.015** (0.013-0.017)	**0.020** (0.018-0.023)	**0.027** (0.023-0.031)	**0.032** (0.028-0.038)	**0.040** (0.034-0.048)	**0.046** (0.038-0.057)	**0.052** (0.042-0.066)	**0.059** (0.046-0.076)	**0.068** (0.051-0.091)	**0.075** (0.055-0.105)
10-day	**0.011** (0.010-0.013)	**0.015** (0.013-0.018)	**0.020** (0.018-0.024)	**0.025** (0.022-0.029)	**0.031** (0.026-0.037)	**0.035** (0.029-0.044)	**0.040** (0.033-0.051)	**0.045** (0.036-0.059)	**0.052** (0.040-0.071)	**0.058** (0.042-0.081)
20-day	**0.007** (0.006-0.008)	**0.009** (0.008-0.011)	**0.013** (0.011-0.015)	**0.015** (0.013-0.018)	**0.019** (0.016-0.023)	**0.022** (0.018-0.027)	**0.025** (0.020-0.032)	**0.028** (0.022-0.037)	**0.033** (0.025-0.044)	**0.037** (0.027-0.051)
30-day	**0.005** (0.005-0.006)	**0.007** (0.007-0.008)	**0.010** (0.009-0.012)	**0.012** (0.011-0.014)	**0.015** (0.013-0.018)	**0.018** (0.015-0.022)	**0.020** (0.016-0.025)	**0.023** (0.018-0.030)	**0.027** (0.020-0.036)	**0.030** (0.022-0.041)
45-day	**0.004** (0.004-0.005)	**0.006** (0.005-0.007)	**0.008** (0.007-0.009)	**0.010** (0.009-0.011)	**0.012** (0.010-0.015)	**0.014** (0.012-0.017)	**0.016** (0.013-0.021)	**0.018** (0.015-0.024)	**0.022** (0.016-0.029)	**0.024** (0.018-0.033)
60-day	**0.004** (0.003-0.004)	**0.005** (0.005-0.006)	**0.007** (0.006-0.008)	**0.009** (0.007-0.010)	**0.011** (0.009-0.013)	**0.012** (0.010-0.015)	**0.014** (0.012-0.018)	**0.016** (0.013-0.021)	**0.019** (0.014-0.025)	**0.021** (0.015-0.029)

[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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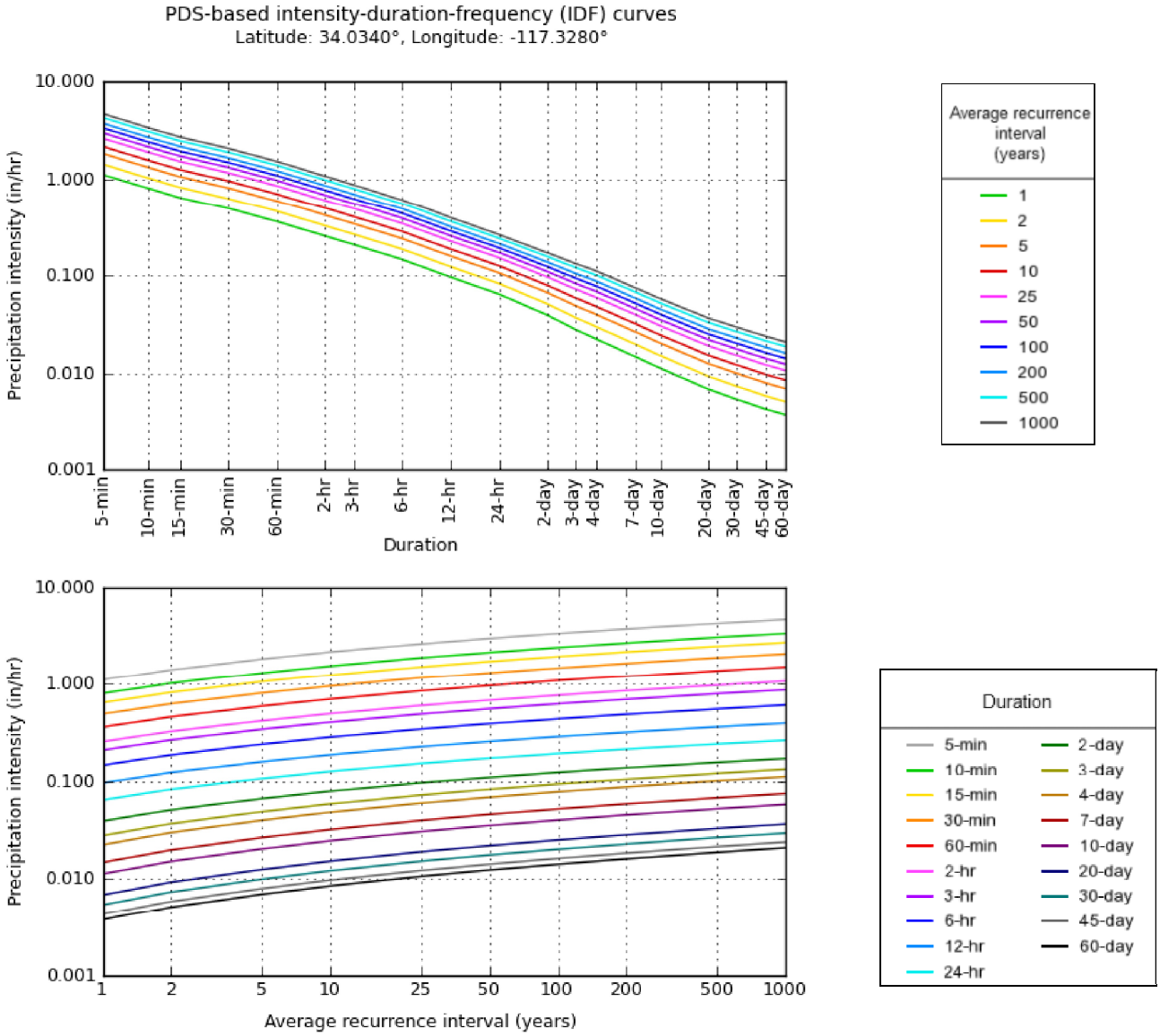
PF graphical



NOAA Atlas 14, Volume 6, Version 2

Created (GMT): Tue Jan 14 16:45:33 2020

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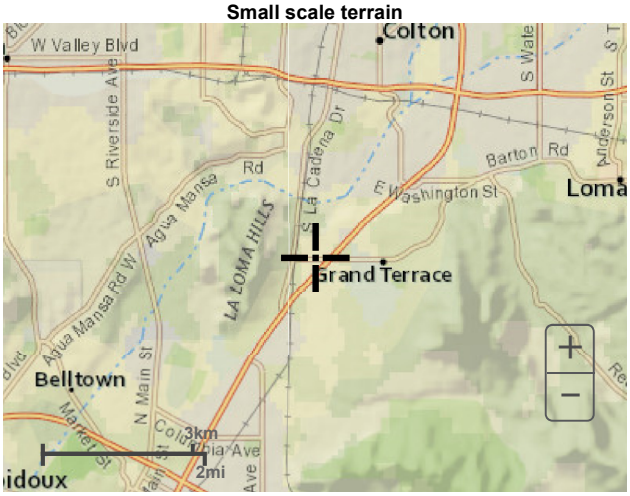
Maps & aerials

Small scale terrain



Large scale terrain

Large scale map

Large scale aerial

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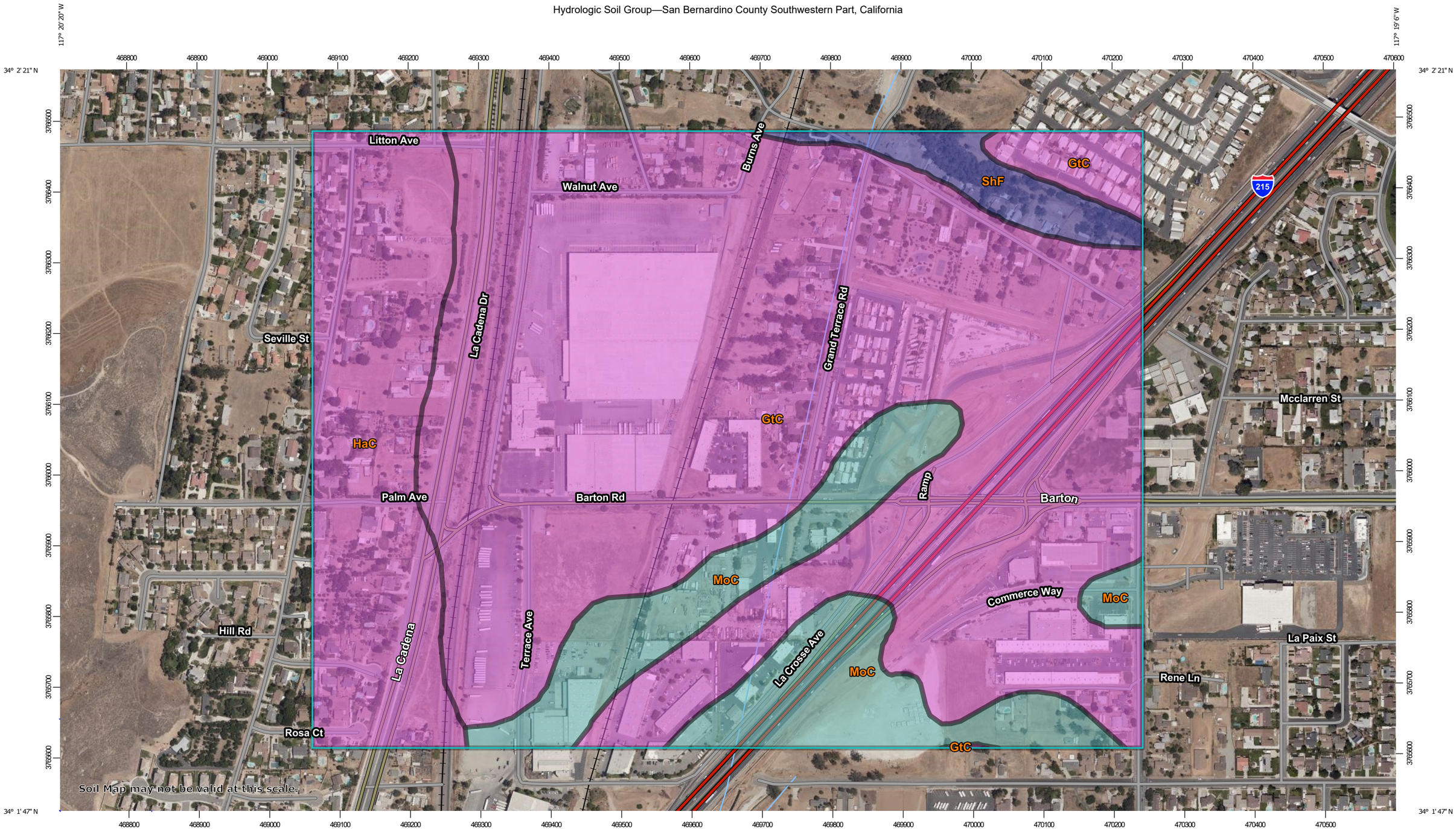
US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

EXCERPT 3: NCRS SOILS DATA


117° 20' 20" W
117° 19' 6" W
34° 2' 21" N
34° 1' 47" N
468800
468900
469000
469100
469200
469300
469400
469500
469600
469700
469800
469900
470000
470100
470200
470300
470400
470500
3766500
3766400
3766300
3766200
3766100
3766000
3765900
3765800
3765700
3765600
Litton Ave
Walnut Ave
Burns Ave
Seville St
La Cadena Dr
Grand Terrace Rd
Mcclarren St
Palm Ave
Barton Rd
Ramp
Barton
Hill Rd
La Cadena
Terrace Ave
La Crosse Ave
Commerce Way
La Paix St
Rene Ln
Rosa Ct
215
GtC
ShF
HaC
MoC
Soil Map may not be valid at this scale.
Map Scale: 1:5,110 if printed on B landscape (17" x 11") sheet.
N
Meters
0 50 100 200 300
Feet
0 200 400 800 1200
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 County Southwestern Part, California
Survey Area Data: Version 11, Sep 16, 2019

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

Date(s) aerial images were photographed: Apr 1, 2018—Jun 30, 2018

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
GtC	Greenfield sandy loam, 2 to 9 percent slopes	A	174.9	68.6%
HaC	Hanford coarse sandy loam, 2 to 9 percent slopes	A	39.4	15.4%
MoC	Monserate sandy loam, 2 to 9 percent slopes	C	33.7	13.2%
ShF	Saugus sandy loam, 30 to 50 percent slopes	B	7.0	2.8%
Totals for Area of Interest			**255.0**	**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

EXCERPT 4: CALTRANS I-215/BARTON ROAD INTERCHANGE HYDROLOGY MAP

DIST	COUNTY	ROUTE	POSTMILE TOTAL PROJECT	SHEET NO	TOTAL SHEETS
08	Riv SBd	215	45.1/45.3 0.0/2.7		3

REGISTERED CIVIL ENGINEER

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — No. — EXP. — CIVIL — STATE OF CALIFORNIA

LIM AND NASCIMENTO ENGINEERING
20 EMPIRE DRIVE
LAKE FOREST, CA 92630
TEL (949) 768-8888 FAX (949) 768-5912

Caltrans now has a web site! To get to the web site, go to: http://www.dot.ca.gov

DATE	REVISED BY
	DATE REVISED

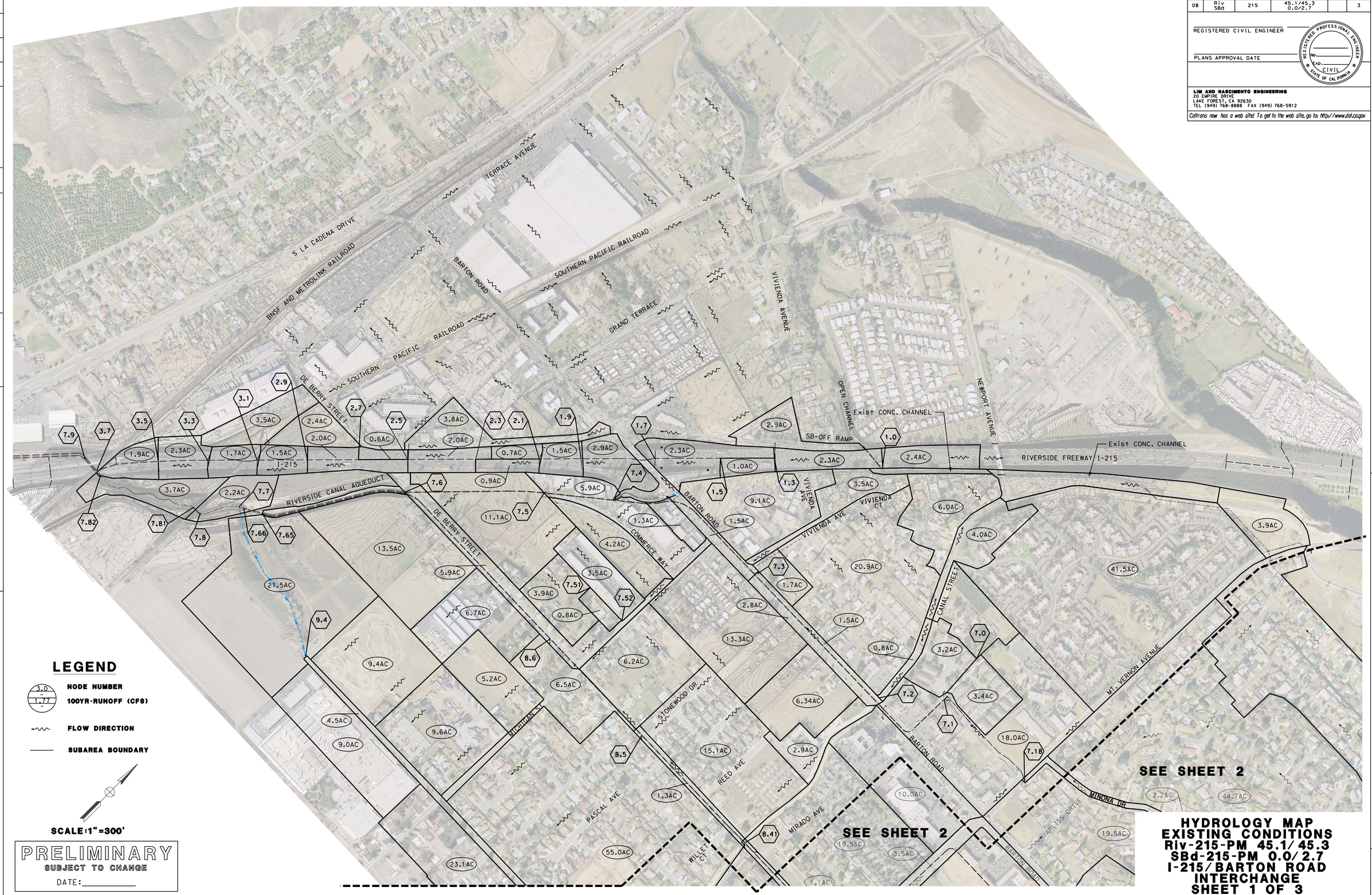
CALCULATED/ DESIGNED BY

CHECKED BY

CONSULTANT FUNCTIONAL SUPERVISOR

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans



LEGEND

- 3.0 / 1.77 — NODE NUMBER / 100YR-RUNOFF (CFS)
- FLOW DIRECTION
- SUBAREA BOUNDARY

SCALE:1"=300'

PRELIMINARY
SUBJECT TO CHANGE
DATE:_____

HYDROLOGY MAP
EXISTING CONDITIONS
Riv-215-PM 45.1/45.3
SBd-215-PM 0.0/2.7
I-215/BARTON ROAD INTERCHANGE
SHEET 1 OF 3

LAST REVISION DATE PLOTTED => $DATE TIME PLOTTED => $TIME
00-00-00

USERNAME => $USER
DGN FILE => $REQUEST

CU 08224

EA 0J0700