Appendix 9.0

Hydrology and Hydraulics Study for KCG BLUE

HYDROLOGY AND HYDRAULICS STUDY FOR KCG BLUE

APN 367-020-038

CITY OF WILDOMAR
CALIFORNIA

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JUNE 5, 2019
REVISED:
SEPTEMBER 3, 2019

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

Joseph L. Castaneda RCE 59835 Registered Civil Engineer	09/03/2019 Date	Seal

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I. PURPOSE AND SCOPE

The KCG Blue project is proposing to develop APN 367-020-038 into an indoor gun range in that will construct a building, parking area, a biofiltration basin, porous pavers, and make improvements along Bundy Canyon Road. The project site will collect the westerly onsite flows and street flows within the biofiltration basin for water quality treatment. The easterly project site will be treated within porous pavers. The scope of the study includes the following:

The scope of the study includes the following:

1. Determination of points of flow concentration and watershed subareas for the onsite areas.
2. Determine the peak 100-year flow rate based upon the post-development condition utilizing the Rational Method as outlined in the Riverside County Flood Control and Water Conservation District (RCFC&WCD) Hydrology Manual.
3. Determine the required storm drain infrastructure to intercept the runoff generated by the project site.
4. Determine the required water quality volume and flow rate to be treated within the biofiltration basin or porous pavers.
5. Preparation of a hydrology report, which consists of hydrological and analytical results and exhibits.

II. PROJECT SITE AND DRAINAGE AREA OVERVIEW

The project site will construct a building, parking lot area, landscaped area, improved street frontage along Bundy Canyon Road, a biofiltration basin and porous pavers. The project is bounded by Bundy Canyon Road to the north, Mission Trails to the west, undeveloped property to the south, and an existing residence to the east. The project site is approximately 2.35 acres and is located in Section 27 of Township 6 South, Range 4 West.

The project site will construct a biofiltration basin at the northwest corner of the project site. The biofiltration basin will treat the required water quality volume for the tributary area, which includes the street improvements along Bundy Canyon Road. Two catch basins are proposed to collect the flow from a majority of the site which includes the improvements to Bundy Canyon Road. Curb openings located adjacent to the biofiltration basins are also proposed to convey project flows that are not collected by the catch basins. The south easterly portion of the project site will utilize porous pavers as self-retaining area for the treatment of this area that cannot be conveyed to the biofiltration basin. These flows will be dispersed via a 60’ riprap dissipation weir that will spread the flows in order to mimic the existing sheet flow condition.

Since water quality treatment for the Bundy Canyon Road street improvements was not feasible within the street right-of-way, the flows are intercepted and conveyed to the biofiltration basin for treatment. Additionally, the offsite flows to the east of the project site will comingle with the onsite flows, however, the flows will not comingle until after the

onsite flows have been treated and before flows are discharged from the proposed U Channel.

The biofiltration basin will store flows for biotreatment. Once the water quality volume is captured, flows will begin to overflow into an outlet structure where flows will be conveyed by on-site storm drains into a channel just south of the project boundary within the road right-of-way. Flows will be discharged near the existing culvert crossing Mission Trail where flows are currently concentrated, therefore dispersion was not required at this location.

III. HYDROLOGY

The Riverside County Hydrology Manual (Reference 1), was used to develop the hydrological parameters for the hydrology analyses. The rational method calculations were performed using the computer program developed by Civil Cadd/Civil Design.

The existing soil classification for the area consists of Hydrologic Soil Group "B" and "C", as shown in Exhibit D. Exhibit D is a Soils Map obtained from the NRCS website. An Antecedent Moisture Condition (AMC) II was utilized for and 100-year and 10-year storm event, as recommended by the Riverside County Hydrology Manual.

The rainfall values were obtained from the Riverside County Hydrology Manual's Isohyetal Maps, and are summarized below:

Storm Event	1-hour
2-Year	0.63
100-Year	1.55

The slope of intensity duration curve value is 0.475. The rainfall maps and the Slope of Intensity Duration Curves have been included as Exhibit E.

The pre-project condition hydrology utilized ½ acre residential land use, commercial land use, and undeveloped – poor cover land use. The pre-project condition also included a small portion south of the project boundary which is not included in the post-project condition calculations. The flow rates at nodes 103 and 105 are 11.44 ft^3/s and 2.18 ft^3/s for a total of 13.62 ft^3/s at the southerly project boundary in the pre-project condition.

The post-project condition consisted of ½ acre residential land use and commercial land use for the offsite areas, commercial land use for the majority of the onsite area, and a user defined land use for Area A4 which includes 15% impervious area with runoff index numbers consistent with turf – fair cover. The commercial land use onsite is considered conservative since the project will incorporate approximately 3,500 sq. ft. of porous pavement that is considered a pervious surface. Flows from the improvements on Bundy Canyon Road are intercepted via a catch basin and conveyed to the onsite biofiltration basin for treatment. Due to the requirement to treat the street improvements, the flows were taken

onsite as the only feasible method for treatment. The flows will discharge the biofiltration basin into a concrete channel located within the Mission Trail right-of-way, and discharge at the near the existing culvert crossing Mission Trail. The flows from the easterly project site will be conveyed via a U channel along the southerly boundary, where treated flows from Areas A3 and A4 will also be conveyed to a rip rap dissipation weir that will disperse the flows in a sheet flow condition to prevent concentration of flows. The post-project flow rate for Area A is 8.18 ft^3/s and the post-project flow rate for Area B is 8.02 ft^3/s.

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

IV. HYDRAULICS

The project site will utilize a U-channel along the easterly and southerly boundary of the site to collect and convey off-site flows impacting the project site from the east, as well as convey the flows from the onsite areas A3 and A4. The flows will be conveyed around the project site and discharged along the southerly project boundary to mimic the existing condition.

The project will utilize a catch basin along Bundy Canyon Road to collect flows from street improvements and convey them into the biofiltration basin through a storm drain. A second catch basin is proposed on-site to capture a portion of the parking area which is also conveyed to the biofiltration basin via storm drain. The remaining area tributary to the westerly basin will surface flow and enter the basin through curb cuts.

The portion of the project site tributary to the southerly U channel will confluence with the easterly offsite area (after the onsite area has been treated with the porous pavers). The flows will then be conveyed to the rip rap dissipation weir where flows will be dispersed in a sheet flow condition.

Flows discharging from the biofiltration basin will be conveyed to a concrete ditch located within the Mission Trail right-of-way. Flows will discharge near the existing culvert crossing Mission Trail.

The biofiltration basin will utilize an inlet with the opening placed 0.5’ above the bottom of the basin. This will allow flows to bypass once the water quality volume is captured. Both treated flows and clean runoff will be conveyed from the biofiltration basin into a single vault with a pump station that will discharge into the basin outlet structure.

V. WATER QUALITY AND MITIGATION

The project will construct a biofiltration basin that will treat the onsite water quality volume, as well as porous pavers that will serve as self-retaining areas for water quality treatment.

The project site will treat the pollutants of concern via a biofiltration basin, porous paver self-retaining areas, and landscaped self-treating areas. The biofiltration basin will treat the pollutants of concern via biofiltration through the soil media. The self-retaining porous paver areas are considered a form of micro-infiltration, and therefore treat the pollutants of concern via micro-infiltration. The self-treating area has virtually no impervious area draining to it and consists nearly entirely of landscaped area, therefore the area is deemed self-treating through the landscaped area.

Flows within the biofiltration will either be pumped out of the biofiltration basin (for the water quality flows that biofiltrate through the soil media into the underdrain system) due to the lack of an existing storm drain within proximity of the biofiltration basin, and the depth at which the underdrain system is located. The flows in excess of the required water quality volume (that pond higher than 0.5 feet above the soil media surface) will be conveyed via an outlet structure directly to the outlet storm drain. This storm drain then discharges into a proposed concrete channel located within the Mission Trail right-of-way. The porous pavers will be designed to provide the minimum 3" ponding below the perforated outlet pipe to adhere to the self-retaining area standards. Flows from the underdrain and peak surface flows will be conveyed to the U Channel along the southerly boundary of the project site. This channel will convey flows to a rip rap dispersion area in which flows will be dispersed in a sheet flow manner, mimicking the existing condition flows.

The Santa Margarita BMP Design Volume Spreadsheet were utilized to determine the required water quality volume for the project site. The land cover for the onsite area consisted of commercial land use. The required water quality volume for the project is 4,058 cu. ft.

The biofiltration basin was sized using the Santa Margarita BMP Design Spreadsheet (included in Appendix C). Utilizing the BMP Volume of 4,058 cu. ft. and the bottom surface area of the biofiltration basin of 1,863 sq. ft., the spreadsheet specifies that the basin is sufficiently sized.

The project site discharges to Lake Elsinore, which is in the Santa Ana Watershed. Based upon the HCOC Applicability Map from the Hydromodification Susceptibility Documentation Report and Mapping for the Santa Ana Region, the project site is exempt from addressing hydromodifications. However, the project will treat the required TMDL's and Constituents of Concern as required by the Santa Margarita Watershed WQMP.

VI. FINDINGS

The hydrology and hydraulic analyses evaluated the proposed development to determine the necessary drainage improvements and BMPs required to treat for water quality purposes. It has been concluded that:

1. The proposed biofiltration basin will adequately treat the required BMP Design Volume.
2. The onsite drainage conveyances will adequately convey the peak 100-year flow rates.

VII. REFERENCES

1. Riverside County Flood Control and Water Conservation District Hydrology Manual, April 1978.
2. Riverside County Flood Control and Water Conservation District Design Handbook for Low Impact Development Best Management Practices, June 2011

FIGURES

FIGURE 1: VICINITY MAP

KCG BLUE SHOOTING RANGE - VICINITY MAP

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FIGURE 1

Drawing Name: O:\132.43.18\Engineering\WQMP\Appendix 1 – Maps & Site Plan\FIGURE 1 – VICINITY MAP.dwg
Last Opened: Jun 05, 2019 – 10:43am by ccastaneda

APPENDICES

APPENDIX A: POST-PROJECT CONDITION HYDROLOGY

APPENDIX A.1: AREA "A" RATIONAL METHOD

100-YEAR STORM EVENT

Riverside County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c) 1989 - 2004 Version 7.0
Rational Hydrology Study Date: 08/28/19 File:ARAEX100.out

KCG BLUE PRE-PROJECT CONDITION HYDROLOGY
RATIONAL METHOD ANALYSIS, 100-YEAR STORM EVENT
FILENAME: ARAEX100

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

English (in-lb) Units used in input data file

Program License Serial Number 433

Rational Method Hydrology Program based on
Riverside County Flood Control & Water Conservation District
1978 hydrology manual

Storm event (year) = 100.00 Antecedent Moisture Condition = 2

2 year, 1 hour precipitation = 0.630(In.)
100 year, 1 hour precipitation = 1.550(In.)

Storm event year = 100.0
Calculated rainfall intensity data:
1 hour intensity = 1.550(In/Hr)
Slope of intensity duration curve = 0.4750

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

Initial area flow distance = 817.000(Ft.)
Top (of initial area) elevation = 1310.800(Ft.)
Bottom (of initial area) elevation = 1296.800(Ft.)
Difference in elevation = 14.000(Ft.)
Slope = 0.01714 s(percent)= 1.71
TC = k(0.420)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration = 13.847 min.
Rainfall intensity = 3.110(In/Hr) for a 100.0 year storm
SINGLE FAMILY (1/2 Acre Lot)
Runoff Coefficient = 0.796
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.360
Decimal fraction soil group C = 0.640
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2) = 64.32
Pervious area fraction = 0.600; Impervious fraction = 0.400
Initial subarea runoff = 7.257(CFS)
Total initial stream area = 2.930(Ac.)
Pervious area fraction = 0.600

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Process from Point/Station 101.000 to Point/Station 102.000
**** SUBAREA FLOW ADDITION ****

COMMERCIAL subarea type
Runoff Coefficient = 0.878
Decimal fraction soil group A = 0.000

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Decimal fraction soil group B = 0.920
Decimal fraction soil group C = 0.080
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2)  =  57.04
Pervious area fraction =  0.100; Impervious fraction =  0.900
Time of concentration =    13.85 min.
Rainfall intensity =      3.110(In/Hr) for a   100.0 year storm
Subarea runoff =      0.601(CFS) for      0.220(Ac.)
Total runoff =      7.857(CFS)        Total area =       3.150(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      102.000 to Point/Station      103.000
**** NATURAL CHANNEL TIME + SUBAREA FLOW ADDITION ****
________________________________________________________________________
Top of natural channel elevation =   1296.800(Ft.)
End of natural channel elevation =   1292.600(Ft.)
Length of natural channel  =   312.000(Ft.)
Estimated mean flow rate at midpoint of channel =      9.728(CFS)

Natural valley channel type used
L.A. County flood control district formula for channel velocity:
 Velocity(ft/s) = (7 + 8(q(English Units)^.352)(slope^0.5)
Velocity using mean channel flow =   2.88(Ft/s)

Correction to map slope used on extremely rugged channels with
drops and waterfalls (Plate D-6.2)
       Normal channel slope =  0.0135
Corrected/adjusted channel slope =  0.0135
Travel time =    1.81 min.     TC =   15.65  min.


 Adding area flow to channel
USER INPUT of soil data for subarea
Runoff Coefficient = 0.813
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.010
Decimal fraction soil group C = 0.990
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2)  =  77.29
Pervious area fraction =  0.820; Impervious fraction =  0.180
Rainfall intensity =      2.934(In/Hr) for a   100.0 year storm
Subarea runoff =      3.579(CFS) for      1.500(Ac.)
Total runoff =     11.436(CFS)        Total area =       4.650(Ac.)


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Process from Point/Station      103.000 to Point/Station      106.000
**** IMPROVED CHANNEL TRAVEL TIME ****
________________________________________________________________________
Upstream point elevation =  1292.600(Ft.)
Downstream point elevation =  1291.000(Ft.)
Channel length thru subarea  =   150.000(Ft.)
Channel base width     =    0.000(Ft.)
Slope or 'Z' of left channel bank =  50.000
Slope or 'Z' of right channel bank =  50.000
Manning's 'N'    = 0.030
Maximum depth of channel  =    0.500(Ft.)
Flow(q) thru subarea =     11.436(CFS)
Depth of flow =   0.371(Ft.), Average velocity =   1.663(Ft/s)
Channel flow top width =   37.083(Ft.)
Flow Velocity =    1.66(Ft/s)
Travel time  =    1.50 min.
Time of concentration =   17.16 min.

Sub-Channel No. 1 Critical depth =      0.318(Ft.)
  '     '       '     Critical flow top width =     31.836(Ft.)
  '     '       '     Critical flow velocity=    2.257(Ft/s)
  '     '       '     Critical flow area =      5.068(Sq.Ft)
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Process from Point/Station      103.000 to Point/Station      106.000
**** CONFLUENCE OF MINOR STREAMS ****
____________________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =      4.650(Ac.)
Runoff from this stream =     11.436(CFS)
Time of concentration =   17.16 min.
Rainfall intensity =     2.809(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      104.000 to Point/Station      105.000
**** INITIAL AREA EVALUATION ****
____________________________________________________________________________
Initial area flow distance =   353.000(Ft.)
Top (of initial area) elevation =  1298.000(Ft.)
Bottom (of initial area) elevation =  1292.500(Ft.)
Difference in elevation =     5.500(Ft.)
Slope =    0.01558  s(percent)=       1.56
TC = k(0.530)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =   12.731 min.
Rainfall intensity =      3.237(In/Hr) for a   100.0 year storm
UNDEVELOPED (poor cover) subarea
Runoff Coefficient = 0.843
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2)  =  86.00
Pervious area fraction =  1.000; Impervious fraction =  0.000
Initial subarea runoff =      2.184(CFS)
Total initial stream area =        0.800(Ac.)
Pervious area fraction = 1.000


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Process from Point/Station      105.000 to Point/Station      106.000
**** NATURAL CHANNEL TIME + SUBAREA FLOW ADDITION ****
____________________________________________________________________________
Top of natural channel elevation =   1292.500(Ft.)
End of natural channel elevation =   1291.000(Ft.)
Length of natural channel  =   112.000(Ft.)
Estimated mean flow rate at midpoint of channel =      2.744(CFS)

Natural valley channel type used
L.A. County flood control district formula for channel velocity:
 Velocity(ft/s) = (7 + 8(q(English Units)^.352)(slope^0.5)
Velocity using mean channel flow =   2.13(Ft/s)

Correction to map slope used on extremely rugged channels with
drops and waterfalls (Plate D-6.2)
       Normal channel slope =  0.0134
Corrected/adjusted channel slope =  0.0134
Travel time =    0.88 min.     TC =   13.61  min.


 Adding area flow to channel
UNDEVELOPED (poor cover) subarea
Runoff Coefficient = 0.842
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2)  =  86.00
Pervious area fraction =  1.000; Impervious fraction =  0.000
Rainfall intensity =      3.136(In/Hr) for a   100.0 year storm
Subarea runoff =      1.082(CFS) for      0.410(Ac.)
Total runoff =      3.267(CFS)       Total area =       1.210(Ac.)
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Process from Point/Station      105.000 to Point/Station      106.000
**** CONFLUENCE OF MINOR STREAMS ****
________________________________________________________________________
Along Main Stream number: 1 in normal stream number 2
Stream flow area =      1.210(Ac.)
Runoff from this stream =      3.267(CFS)
Time of concentration =   13.61 min.
Rainfall intensity =     3.136(In/Hr)
Summary of stream data:

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


1       11.436     17.16                2.809
2        3.267     13.61                3.136
Largest stream flow has longer time of concentration
Qp =     11.436 + sum of
          Qb          Ia/Ib
           3.267 *    0.896 =      2.926
Qp =     14.362

Total of 2 streams to confluence:
Flow rates before confluence point:
      11.436       3.267
Area of streams before confluence:
        4.650        1.210
Results of confluence:
Total flow rate =     14.362(CFS)
Time of concentration =    17.156 min.
Effective stream area after confluence =      5.860(Ac.)
End of computations, total study area =            5.86 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.

Area averaged pervious area fraction(Ap) = 0.720
Area averaged RI index number =  71.8
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10-YEAR STORM EVENT

Riverside County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c) 1989 - 2004 Version 7.0
Rational Hydrology Study Date: 08/28/19 File:ARAEX10.out

KCG BLUE PRE-PROJECT CONDITION HYDROLOGY
RATIONAL METHOD ANALYSIS, 10-YEAR STORM EVENT
FILENAME: ARAEX10

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

English (in-lb) Units used in input data file

Program License Serial Number 433

Rational Method Hydrology Program based on
Riverside County Flood Control & Water Conservation District
1978 hydrology manual

Storm event (year) = 10.00 Antecedent Moisture Condition = 2

2 year, 1 hour precipitation = 0.630(In.)
100 year, 1 hour precipitation = 1.550(In.)

Storm event year = 10.0
Calculated rainfall intensity data:
1 hour intensity = 1.008(In/Hr)
Slope of intensity duration curve = 0.4750

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

Initial area flow distance = 817.000(Ft.)
Top (of initial area) elevation = 1310.800(Ft.)
Bottom (of initial area) elevation = 1296.800(Ft.)
Difference in elevation = 14.000(Ft.)
Slope = 0.01714 s(percent)= 1.71
TC = k(0.420)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration = 13.847 min.
Rainfall intensity = 2.024(In/Hr) for a 10.0 year storm
SINGLE FAMILY (1/2 Acre Lot)
Runoff Coefficient = 0.755
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.360
Decimal fraction soil group C = 0.640
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2) = 64.32
Pervious area fraction = 0.600; Impervious fraction = 0.400
Initial subarea runoff = 4.480(CFS)
Total initial stream area = 2.930(Ac.)
Pervious area fraction = 0.600

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Process from Point/Station 101.000 to Point/Station 102.000
**** SUBAREA FLOW ADDITION ****

COMMERCIAL subarea type
Runoff Coefficient = 0.870
Decimal fraction soil group A = 0.000

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Decimal fraction soil group B = 0.920
Decimal fraction soil group C = 0.080
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2)  =  57.04
Pervious area fraction =  0.100; Impervious fraction =  0.900
Time of concentration =    13.85 min.
Rainfall intensity =      2.024(In/Hr) for a    10.0 year storm
Subarea runoff =      0.387(CFS) for      0.220(Ac.)
Total runoff =      4.867(CFS)        Total area =       3.150(Ac.)


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Process from Point/Station      102.000 to Point/Station      103.000
**** NATURAL CHANNEL TIME + SUBAREA FLOW ADDITION ****
________________________________________________________________________
Top of natural channel elevation =   1296.800(Ft.)
End of natural channel elevation =   1292.600(Ft.)
Length of natural channel  =   312.000(Ft.)
Estimated mean flow rate at midpoint of channel =      6.026(CFS)

Natural valley channel type used
L.A. County flood control district formula for channel velocity:
 Velocity(ft/s) = (7 + 8(q(English Units)^.352)(slope^0.5)
Velocity using mean channel flow =   2.56(Ft/s)

Correction to map slope used on extremely rugged channels with
drops and waterfalls (Plate D-6.2)
       Normal channel slope =  0.0135
Corrected/adjusted channel slope =  0.0135
Travel time =    2.03 min.     TC =   15.88  min.


 Adding area flow to channel
USER INPUT of soil data for subarea
Runoff Coefficient = 0.774
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.010
Decimal fraction soil group C = 0.990
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2)  =  77.29
Pervious area fraction =  0.820; Impervious fraction =  0.180
Rainfall intensity =      1.896(In/Hr) for a    10.0 year storm
Subarea runoff =      2.201(CFS) for      1.500(Ac.)
Total runoff =      7.067(CFS)        Total area =       4.650(Ac.)


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Process from Point/Station      103.000 to Point/Station      106.000
**** IMPROVED CHANNEL TRAVEL TIME ****
________________________________________________________________________
Upstream point elevation =  1292.600(Ft.)
Downstream point elevation =  1291.000(Ft.)
Channel length thru subarea  =   150.000(Ft.)
Channel base width     =    0.000(Ft.)
Slope or 'Z' of left channel bank =  50.000
Slope or 'Z' of right channel bank =  50.000
Manning's 'N'    = 0.030
Maximum depth of channel  =    0.500(Ft.)
Flow(q) thru subarea =      7.067(CFS)
Depth of flow =   0.310(Ft.), Average velocity =   1.475(Ft/s)
Channel flow top width =   30.960(Ft.)
Flow Velocity =    1.47(Ft/s)
Travel time  =    1.70 min.
Time of concentration =   17.57 min.

Sub-Channel No. 1 Critical depth =      0.262(Ft.)
  '     '       '     Critical flow top width =     26.172(Ft.)
  '     '       '     Critical flow velocity=    2.064(Ft/s)
  '     '       '     Critical flow area =      3.425(Sq.Ft)
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Process from Point/Station      103.000 to Point/Station      106.000
**** CONFLUENCE OF MINOR STREAMS ****
____________________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =      4.650(Ac.)
Runoff from this stream =      7.067(CFS)
Time of concentration =   17.57 min.
Rainfall intensity =     1.807(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      104.000 to Point/Station      105.000
**** INITIAL AREA EVALUATION ****
____________________________________________________________________________
Initial area flow distance =   353.000(Ft.)
Top (of initial area) elevation =  1298.000(Ft.)
Bottom (of initial area) elevation =  1292.500(Ft.)
Difference in elevation =     5.500(Ft.)
Slope =    0.01558  s(percent)=       1.56
TC = k(0.530)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =   12.731 min.
Rainfall intensity =      2.106(In/Hr) for a    10.0 year storm
UNDEVELOPED (poor cover) subarea
Runoff Coefficient = 0.816
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2)  =  86.00
Pervious area fraction =  1.000; Impervious fraction =  0.000
Initial subarea runoff =      1.375(CFS)
Total initial stream area =        0.800(Ac.)
Pervious area fraction = 1.000


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      105.000 to Point/Station      106.000
**** NATURAL CHANNEL TIME + SUBAREA FLOW ADDITION ****
____________________________________________________________________________
Top of natural channel elevation =   1292.500(Ft.)
End of natural channel elevation =   1291.000(Ft.)
Length of natural channel  =   112.000(Ft.)
Estimated mean flow rate at midpoint of channel =      1.727(CFS)

Natural valley channel type used
L.A. County flood control district formula for channel velocity:
 Velocity(ft/s) = (7 + 8(q(English Units)^.352)(slope^0.5)
Velocity using mean channel flow =   1.93(Ft/s)

Correction to map slope used on extremely rugged channels with
drops and waterfalls (Plate D-6.2)
       Normal channel slope =  0.0134
Corrected/adjusted channel slope =  0.0134
Travel time =    0.97 min.     TC =   13.70  min.


 Adding area flow to channel
UNDEVELOPED (poor cover) subarea
Runoff Coefficient = 0.813
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2)  =  86.00
Pervious area fraction =  1.000; Impervious fraction =  0.000
Rainfall intensity =      2.034(In/Hr) for a    10.0 year storm
Subarea runoff =      0.678(CFS) for      0.410(Ac.)
Total runoff =      2.053(CFS)       Total area =       1.210(Ac.)
```

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      105.000 to Point/Station      106.000
**** CONFLUENCE OF MINOR STREAMS ****
________________________________________________________________________
Along Main Stream number: 1 in normal stream number 2
Stream flow area =      1.210(Ac.)
Runoff from this stream =      2.053(CFS)
Time of concentration =   13.70 min.
Rainfall intensity =     2.034(In/Hr)
Summary of stream data:

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


1        7.067     17.57                 1.807
2        2.053     13.70                 2.034
Largest stream flow has longer time of concentration
Qp =      7.067 + sum of
          Qb         Ia/Ib
           2.053 *    0.888 =      1.824
Qp =      8.891

Total of 2 streams to confluence:
Flow rates before confluence point:
       7.067       2.053
Area of streams before confluence:
        4.650        1.210
Results of confluence:
Total flow rate =      8.891(CFS)
Time of concentration =    17.575 min.
Effective stream area after confluence =      5.860(Ac.)
End of computations, total study area =            5.86 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.

Area averaged pervious area fraction(Ap) = 0.720
Area averaged RI index number =  71.8
```

APPENDIX B: POST-PROJECT CONDITION HYDROLOGY

APPENDIX B.1: AREA "A" RATIONAL METHOD

100-YEAR STORM EVENT

Riverside County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c) 1989 - 2004 Version 7.0
Rational Hydrology Study Date: 08/28/19 File:ARAP100.out

KCG BLUE POST-PROJECT CONDITION HYDROLOGY
RATIONAL METHOD ANALYSIS, 100-YEAR STORM EVENT
FILENAME: ARAP100

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

English (in-lb) Units used in input data file

Program License Serial Number 433

Rational Method Hydrology Program based on
Riverside County Flood Control & Water Conservation District
1978 hydrology manual

Storm event (year) = 100.00 Antecedent Moisture Condition = 2

2 year, 1 hour precipitation = 0.630(In.)
100 year, 1 hour precipitation = 1.550(In.)

Storm event year = 100.0
Calculated rainfall intensity data:
1 hour intensity = 1.550(In/Hr)
Slope of intensity duration curve = 0.4750

++

Process from Point/Station 101.000 to Point/Station 103.000
**** INITIAL AREA EVALUATION ****

Initial area flow distance = 1000.000(Ft.)
Top (of initial area) elevation = 1308.600(Ft.)
Bottom (of initial area) elevation = 1294.800(Ft.)
Difference in elevation = 13.800(Ft.)
Slope = 0.01380 s(percent)= 1.38
TC = k(0.420)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration = 15.677 min.
Rainfall intensity = 2.932(In/Hr) for a 100.0 year storm
SINGLE FAMILY (1/2 Acre Lot)
Runoff Coefficient = 0.791
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.370
Decimal fraction soil group C = 0.630
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2) = 64.19
Pervious area fraction = 0.600; Impervious fraction = 0.400
Initial subarea runoff = 6.840(CFS)
Total initial stream area = 2.950(Ac.)
Pervious area fraction = 0.600

++

Process from Point/Station 101.000 to Point/Station 103.000
**** SUBAREA FLOW ADDITION ****

COMMERCIAL subarea type
Runoff Coefficient = 0.877
Decimal fraction soil group A = 0.000

```
Decimal fraction soil group B = 0.920
Decimal fraction soil group C = 0.080
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2)  =  57.04
Pervious area fraction =  0.100; Impervious fraction =  0.900
Time of concentration =    15.68 min.
Rainfall intensity =      2.932(In/Hr) for a   100.0 year storm
Subarea runoff =      0.566(CFS) for      0.220(Ac.)
Total runoff =      7.406(CFS)        Total area =       3.170(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      101.000 to Point/Station      103.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =      3.170(Ac.)
Runoff from this stream =      7.406(CFS)
Time of concentration =   15.68 min.
Rainfall intensity =     2.932(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      102.000 to Point/Station      103.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________________
Initial area flow distance =   187.000(Ft.)
Top (of initial area) elevation =  1299.000(Ft.)
Bottom (of initial area) elevation =  1294.800(Ft.)
Difference in elevation =     4.200(Ft.)
Slope =    0.02246  s(percent)=       2.25
TC = k(0.300)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =    5.195 min.
Rainfall intensity =      4.955(In/Hr) for a   100.0 year storm
COMMERCIAL subarea type
Runoff Coefficient = 0.885
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.920
Decimal fraction soil group C = 0.080
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2)  =  57.04
Pervious area fraction =  0.100; Impervious fraction =  0.900
Initial subarea runoff =      0.965(CFS)
Total initial stream area =        0.220(Ac.)
Pervious area fraction = 0.100


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      102.000 to Point/Station      103.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________________
Along Main Stream number: 1 in normal stream number 2
Stream flow area =      0.220(Ac.)
Runoff from this stream =      0.965(CFS)
Time of concentration =    5.19 min.
Rainfall intensity =     4.955(In/Hr)
Summary of stream data:

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


1        7.406     15.68                 2.932
2        0.965      5.19                 4.955
Largest stream flow has longer time of concentration
Qp =      7.406 + sum of
          Qb         Ia/Ib
           0.965 *    0.592 =      0.571
Qp =      7.976

Total of 2 streams to confluence:
```

```
Flow rates before confluence point:
       7.406       0.965
Area of streams before confluence:
        3.170        0.220
Results of confluence:
Total flow rate =      7.976(CFS)
Time of concentration =    15.677 min.
Effective stream area after confluence =      3.390(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      103.000 to Point/Station      104.000
**** IMPROVED CHANNEL TRAVEL TIME ****
________________________________________________________________________
Upstream point elevation =  1294.800(Ft.)
Downstream point elevation =  1293.600(Ft.)
Channel length thru subarea  =   255.000(Ft.)
Channel base width     =    2.000(Ft.)
Slope or 'Z' of left channel bank =   0.000
Slope or 'Z' of right channel bank =   0.000
Estimated mean flow rate at midpoint of channel =      8.082(CFS)
Manning's 'N'    = 0.015
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =      8.082(CFS)
Depth of flow =   0.958(Ft.), Average velocity =   4.219(Ft/s)
Channel flow top width =    2.000(Ft.)
Flow Velocity =    4.22(Ft/s)
Travel time  =    1.01 min.
Time of concentration =   16.68 min.

Sub-Channel No. 1 Critical depth =      0.797(Ft.)
  '     '       '     Critical flow top width =      2.000(Ft.)
  '     '       '     Critical flow velocity=    5.071(Ft/s)
  '     '       '     Critical flow area =      1.594(Sq.Ft)

 Adding area flow to channel
USER INPUT of soil data for subarea
Runoff Coefficient = 0.801
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2)  =  77.00
Pervious area fraction =  0.900; Impervious fraction =  0.100
Rainfall intensity =      2.847(In/Hr) for a   100.0 year storm
Subarea runoff =      0.205(CFS) for      0.090(Ac.)
Total runoff =      8.182(CFS)       Total area =       3.480(Ac.)
Depth of flow =   0.966(Ft.), Average velocity =   4.232(Ft/s)

Sub-Channel No. 1 Critical depth =      0.805(Ft.)
  '     '       '     Critical flow top width =      2.000(Ft.)
  '     '       '     Critical flow velocity=    5.084(Ft/s)
  '     '       '     Critical flow area =      1.609(Sq.Ft)

End of computations, total study area =            3.48 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.

Area averaged pervious area fraction(Ap) = 0.545
Area averaged RI index number =  63.6
```

10-YEAR STORM EVENT

Riverside County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c) 1989 - 2004 Version 7.0
Rational Hydrology Study Date: 08/28/19 File:ARAP10.out

KCG BLUE POST-PROJECT CONDITION HYDROLOGY
RATIONAL METHOD ANALYSIS, 10-YEAR STORM EVENT
FILENAME: ARAP10

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

English (in-lb) Units used in input data file

Program License Serial Number 433

Rational Method Hydrology Program based on
Riverside County Flood Control & Water Conservation District
1978 hydrology manual

Storm event (year) = 10.00 Antecedent Moisture Condition = 2

2 year, 1 hour precipitation = 0.630(In.)
100 year, 1 hour precipitation = 1.550(In.)

Storm event year = 10.0
Calculated rainfall intensity data:
1 hour intensity = 1.008(In/Hr)
Slope of intensity duration curve = 0.4750

++

Process from Point/Station 101.000 to Point/Station 103.000
**** INITIAL AREA EVALUATION ****

Initial area flow distance = 1000.000(Ft.)
Top (of initial area) elevation = 1308.600(Ft.)
Bottom (of initial area) elevation = 1294.800(Ft.)
Difference in elevation = 13.800(Ft.)
Slope = 0.01380 s(percent)= 1.38
TC = k(0.420)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration = 15.677 min.
Rainfall intensity = 1.908(In/Hr) for a 10.0 year storm
SINGLE FAMILY (1/2 Acre Lot)
Runoff Coefficient = 0.749
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.370
Decimal fraction soil group C = 0.630
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2) = 64.19
Pervious area fraction = 0.600; Impervious fraction = 0.400
Initial subarea runoff = 4.213(CFS)
Total initial stream area = 2.950(Ac.)
Pervious area fraction = 0.600

++

Process from Point/Station 101.000 to Point/Station 103.000
**** SUBAREA FLOW ADDITION ****

COMMERCIAL subarea type
Runoff Coefficient = 0.869
Decimal fraction soil group A = 0.000

```
Decimal fraction soil group B = 0.920
Decimal fraction soil group C = 0.080
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2)  =  57.04
Pervious area fraction =  0.100; Impervious fraction =  0.900
Time of concentration =    15.68 min.
Rainfall intensity =      1.908(In/Hr) for a    10.0 year storm
Subarea runoff =      0.365(CFS) for      0.220(Ac.)
Total runoff =      4.577(CFS)        Total area =       3.170(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      101.000 to Point/Station      103.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =      3.170(Ac.)
Runoff from this stream =      4.577(CFS)
Time of concentration =   15.68 min.
Rainfall intensity =     1.908(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      102.000 to Point/Station      103.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________________
Initial area flow distance =   187.000(Ft.)
Top (of initial area) elevation =  1299.000(Ft.)
Bottom (of initial area) elevation =  1294.800(Ft.)
Difference in elevation =     4.200(Ft.)
Slope =    0.02246  s(percent)=       2.25
TC = k(0.300)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =    5.195 min.
Rainfall intensity =      3.224(In/Hr) for a    10.0 year storm
COMMERCIAL subarea type
Runoff Coefficient = 0.879
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.920
Decimal fraction soil group C = 0.080
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2)  =  57.04
Pervious area fraction =  0.100; Impervious fraction =  0.900
Initial subarea runoff =      0.623(CFS)
Total initial stream area =        0.220(Ac.)
Pervious area fraction = 0.100


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      102.000 to Point/Station      103.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________________
Along Main Stream number: 1 in normal stream number 2
Stream flow area =      0.220(Ac.)
Runoff from this stream =      0.623(CFS)
Time of concentration =    5.19 min.
Rainfall intensity =     3.224(In/Hr)
Summary of stream data:

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


1        4.577     15.68                 1.908
2        0.623      5.19                 3.224
Largest stream flow has longer time of concentration
Qp =      4.577 + sum of
          Qb         Ia/Ib
           0.623 *    0.592 =      0.369
Qp =      4.946

Total of 2 streams to confluence:
```

```
Flow rates before confluence point:
       4.577       0.623
Area of streams before confluence:
        3.170        0.220
Results of confluence:
Total flow rate =      4.946(CFS)
Time of concentration =    15.677 min.
Effective stream area after confluence =      3.390(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      103.000 to Point/Station      104.000
**** IMPROVED CHANNEL TRAVEL TIME ****
________________________________________________________________________
Upstream point elevation =  1294.800(Ft.)
Downstream point elevation =  1293.600(Ft.)
Channel length thru subarea  =   255.000(Ft.)
Channel base width     =    2.000(Ft.)
Slope or 'Z' of left channel bank =   0.000
Slope or 'Z' of right channel bank =   0.000
Estimated mean flow rate at midpoint of channel =      5.012(CFS)
Manning's 'N'    = 0.015
Maximum depth of channel  =    1.000(Ft.)
Flow(q) thru subarea =      5.012(CFS)
Depth of flow =   0.676(Ft.), Average velocity =   3.709(Ft/s)
Channel flow top width =    2.000(Ft.)
Flow Velocity =    3.71(Ft/s)
Travel time  =    1.15 min.
Time of concentration =   16.82 min.

Sub-Channel No. 1 Critical depth =      0.578(Ft.)
  '     '       '     Critical flow top width =      2.000(Ft.)
  '     '       '     Critical flow velocity=    4.335(Ft/s)
  '     '       '     Critical flow area =      1.156(Sq.Ft)

 Adding area flow to channel
USER INPUT of soil data for subarea
Runoff Coefficient = 0.756
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2)  =  77.00
Pervious area fraction =  0.900; Impervious fraction =  0.100
Rainfall intensity =      1.845(In/Hr) for a    10.0 year storm
Subarea runoff =      0.126(CFS) for      0.090(Ac.)
Total runoff =      5.072(CFS)        Total area =       3.480(Ac.)
Depth of flow =   0.681(Ft.), Average velocity =   3.722(Ft/s)

Sub-Channel No. 1 Critical depth =      0.586(Ft.)
  '     '       '     Critical flow top width =      2.000(Ft.)
  '     '       '     Critical flow velocity=    4.328(Ft/s)
  '     '       '     Critical flow area =      1.172(Sq.Ft)

End of computations, total study area =            3.48 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.

Area averaged pervious area fraction(Ap) = 0.545
Area averaged RI index number =  63.6
```

APPENDIX B.2: AREA "B" RATIONAL METHOD

100-YEAR STORM EVENT

Riverside County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c) 1989 - 2004 Version 7.0
Rational Hydrology Study Date: 08/28/19 File:ARBP100.out

KCG BLUE POST-PROJECT CONDITION HYDROLOGY
RATIONAL METHOD ANALYSIS, 100-YEAR STORM EVENT
FILENAME: ARBP100

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

English (in-lb) Units used in input data file

Program License Serial Number 433

Rational Method Hydrology Program based on
Riverside County Flood Control & Water Conservation District
1978 hydrology manual

Storm event (year) = 100.00 Antecedent Moisture Condition = 2

2 year, 1 hour precipitation = 0.630(In.)
100 year, 1 hour precipitation = 1.550(In.)

Storm event year = 100.0
Calculated rainfall intensity data:
1 hour intensity = 1.550(In/Hr)
Slope of intensity duration curve = 0.4750

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

Initial area flow distance = 385.000(Ft.)
Top (of initial area) elevation = 1299.300(Ft.)
Bottom (of initial area) elevation = 1294.300(Ft.)
Difference in elevation = 5.000(Ft.)
Slope = 0.01299 s(percent)= 1.30
TC = k(0.300)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration = 7.738 min.
Rainfall intensity = 4.101(In/Hr) for a 100.0 year storm
COMMERCIAL subarea type
Runoff Coefficient = 0.888
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.020
Decimal fraction soil group C = 0.980
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2) = 68.74
Pervious area fraction = 0.100; Impervious fraction = 0.900
Initial subarea runoff = 1.676(CFS)
Total initial stream area = 0.460(Ac.)
Pervious area fraction = 0.100

++
Process from Point/Station 202.000 to Point/Station 205.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****

Upstream point/station elevation = 1290.500(Ft.)
Downstream point/station elevation = 1290.400(Ft.)
Pipe length = 30.00(Ft.) Manning's N = 0.013

```
No. of pipes = 1  Required pipe flow  =     1.676(CFS)
Nearest computed pipe diameter  =     12.00(In.)
Calculated individual pipe flow  =     1.676(CFS)
Normal flow depth in pipe =    8.23(In.)
Flow top width inside pipe =   11.14(In.)
Critical Depth =    6.60(In.)
Pipe flow velocity =      2.92(Ft/s)
Travel time through pipe =    0.17 min.
Time of concentration (TC) =     7.91 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      202.000 to Point/Station      205.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =      0.460(Ac.)
Runoff from this stream =      1.676(CFS)
Time of concentration =    7.91 min.
Rainfall intensity =     4.058(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      203.000 to Point/Station      204.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________________
Initial area flow distance =   170.000(Ft.)
Top (of initial area) elevation =  1299.000(Ft.)
Bottom (of initial area) elevation =  1294.500(Ft.)
Difference in elevation =     4.500(Ft.)
Slope =    0.02647  s(percent)=       2.65
TC = k(0.300)*[(length^3)/(elevation change)]^0.2
Warning: TC computed to be less than 5 min.; program is assuming the
time of concentration is 5 minutes.
Initial area time of concentration =    5.000 min.
Rainfall intensity =      5.046(In/Hr) for a   100.0 year storm
COMMERCIAL subarea type
Runoff Coefficient = 0.890
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2)  =  69.00
Pervious area fraction =  0.100; Impervious fraction =  0.900
Initial subarea runoff =      3.190(CFS)
Total initial stream area =        0.710(Ac.)
Pervious area fraction = 0.100


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      204.000 to Point/Station      205.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________________
Upstream point/station elevation =  1291.600(Ft.)
Downstream point/station elevation =  1290.400(Ft.)
Pipe length  =   225.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     3.190(CFS)
Nearest computed pipe diameter  =     15.00(In.)
Calculated individual pipe flow  =     3.190(CFS)
Normal flow depth in pipe =    9.04(In.)
Flow top width inside pipe =   14.68(In.)
Critical Depth =    8.64(In.)
Pipe flow velocity =      4.13(Ft/s)
Travel time through pipe =    0.91 min.
Time of concentration (TC) =     5.91 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      204.000 to Point/Station      205.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________________
```

```
Along Main Stream number: 1 in normal stream number 2
Stream flow area =      0.710(Ac.)
Runoff from this stream =      3.190(CFS)
Time of concentration =    5.91 min.
Rainfall intensity =     4.661(In/Hr)
Summary of stream data:

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


1        1.676      7.91                4.058
2        3.190      5.91                4.661
Largest stream flow has longer or shorter time of concentration
Qp =      3.190 + sum of
          Qa          Tb/Ta
           1.676 *    0.747 =      1.252
Qp =      4.442

Total of 2 streams to confluence:
Flow rates before confluence point:
       1.676       3.190
Area of streams before confluence:
        0.460        0.710
Results of confluence:
Total flow rate =      4.442(CFS)
Time of concentration =     5.908 min.
Effective stream area after confluence =      1.170(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      205.000 to Point/Station      207.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________________
Upstream point/station elevation =  1290.400(Ft.)
Downstream point/station elevation =  1290.000(Ft.)
Pipe length  =   123.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     4.442(CFS)
Nearest computed pipe diameter  =     18.00(In.)
Calculated individual pipe flow  =     4.442(CFS)
Normal flow depth in pipe =   11.54(In.)
Flow top width inside pipe =   17.27(In.)
Critical Depth =    9.70(In.)
Pipe flow velocity =      3.71(Ft/s)
Travel time through pipe =    0.55 min.
Time of concentration (TC) =     6.46 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      205.000 to Point/Station      207.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =      1.170(Ac.)
Runoff from this stream =      4.442(CFS)
Time of concentration =    6.46 min.
Rainfall intensity =     4.468(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      206.000 to Point/Station      207.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________________
Initial area flow distance =   246.000(Ft.)
Top (of initial area) elevation =  1296.300(Ft.)
Bottom (of initial area) elevation =  1290.000(Ft.)
Difference in elevation =     6.300(Ft.)
Slope =    0.02561  s(percent)=       2.56
TC = k(0.300)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =    5.647 min.
Rainfall intensity =      4.763(In/Hr) for a   100.0 year storm
```

```
COMMERCIAL subarea type
Runoff Coefficient = 0.890
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2)  =  69.00
Pervious area fraction =  0.100; Impervious fraction =  0.900
Initial subarea runoff =      3.815(CFS)
Total initial stream area =        0.900(Ac.)
Pervious area fraction = 0.100


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      206.000 to Point/Station      207.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________________
Along Main Stream number: 1 in normal stream number 2
Stream flow area =      0.900(Ac.)
Runoff from this stream =      3.815(CFS)
Time of concentration =    5.65 min.
Rainfall intensity =     4.763(In/Hr)
Summary of stream data:

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


1        4.442      6.46                 4.468
2        3.815      5.65                 4.763
Largest stream flow has longer time of concentration
Qp =      4.442 + sum of
          Qb         Ia/Ib
           3.815 *    0.938 =      3.578
Qp =      8.020

Total of 2 streams to confluence:
Flow rates before confluence point:
       4.442       3.815
Area of streams before confluence:
        1.170        0.900
Results of confluence:
Total flow rate =      8.020(CFS)
Time of concentration =     6.461 min.
Effective stream area after confluence =      2.070(Ac.)
End of computations, total study area =            2.07 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.

Area averaged pervious area fraction(Ap) = 0.100
Area averaged RI index number =  68.9
```

10-YEAR STORM EVENT

Riverside County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c) 1989 - 2004 Version 7.0
Rational Hydrology Study Date: 08/28/19 File:ARBP10.out

KCG BLUE POST-PROJECT CONDITION HYDROLOGY
RATIONAL METHOD ANALYSIS, 10-YEAR STORM EVENT
FILENAME: ARBP10

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

English (in-lb) Units used in input data file

Program License Serial Number 433

Rational Method Hydrology Program based on
Riverside County Flood Control & Water Conservation District
1978 hydrology manual

Storm event (year) = 10.00 Antecedent Moisture Condition = 2

2 year, 1 hour precipitation = 0.630(In.)
100 year, 1 hour precipitation = 1.550(In.)

Storm event year = 10.0
Calculated rainfall intensity data:
1 hour intensity = 1.008(In/Hr)
Slope of intensity duration curve = 0.4750

++

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

Initial area flow distance = 385.000(Ft.)
Top (of initial area) elevation = 1299.300(Ft.)
Bottom (of initial area) elevation = 1294.300(Ft.)
Difference in elevation = 5.000(Ft.)
Slope = 0.01299 s(percent)= 1.30
TC = k(0.300)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration = 7.738 min.
Rainfall intensity = 2.668(In/Hr) for a 10.0 year storm
COMMERCIAL subarea type
Runoff Coefficient = 0.883
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.020
Decimal fraction soil group C = 0.980
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2) = 68.74
Pervious area fraction = 0.100; Impervious fraction = 0.900
Initial subarea runoff = 1.084(CFS)
Total initial stream area = 0.460(Ac.)
Pervious area fraction = 0.100

++

Process from Point/Station 202.000 to Point/Station 205.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****

Upstream point/station elevation = 1290.500(Ft.)
Downstream point/station elevation = 1290.400(Ft.)
Pipe length = 30.00(Ft.) Manning's N = 0.013

```
No. of pipes = 1  Required pipe flow  =     1.084(CFS)
Nearest computed pipe diameter  =     12.00(In.)
Calculated individual pipe flow  =     1.084(CFS)
Normal flow depth in pipe =    6.19(In.)
Flow top width inside pipe =   11.99(In.)
Critical Depth =    5.26(In.)
Pipe flow velocity =      2.65(Ft/s)
Travel time through pipe =    0.19 min.
Time of concentration (TC) =     7.93 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      202.000 to Point/Station      205.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =      0.460(Ac.)
Runoff from this stream =      1.084(CFS)
Time of concentration =    7.93 min.
Rainfall intensity =     2.638(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      203.000 to Point/Station      204.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________________
Initial area flow distance =   170.000(Ft.)
Top (of initial area) elevation =  1299.000(Ft.)
Bottom (of initial area) elevation =  1294.500(Ft.)
Difference in elevation =     4.500(Ft.)
Slope =    0.02647  s(percent)=       2.65
TC = k(0.300)*[(length^3)/(elevation change)]^0.2
Warning: TC computed to be less than 5 min.; program is assuming the
time of concentration is 5 minutes.
Initial area time of concentration =    5.000 min.
Rainfall intensity =      3.283(In/Hr) for a    10.0 year storm
COMMERCIAL subarea type
Runoff Coefficient = 0.886
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2)  =  69.00
Pervious area fraction =  0.100; Impervious fraction =  0.900
Initial subarea runoff =      2.066(CFS)
Total initial stream area =        0.710(Ac.)
Pervious area fraction = 0.100


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      204.000 to Point/Station      205.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________________
Upstream point/station elevation =  1291.600(Ft.)
Downstream point/station elevation =  1290.400(Ft.)
Pipe length  =   225.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     2.066(CFS)
Nearest computed pipe diameter  =     12.00(In.)
Calculated individual pipe flow  =     2.066(CFS)
Normal flow depth in pipe =    8.07(In.)
Flow top width inside pipe =   11.26(In.)
Critical Depth =    7.36(In.)
Pipe flow velocity =      3.68(Ft/s)
Travel time through pipe =    1.02 min.
Time of concentration (TC) =     6.02 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      204.000 to Point/Station      205.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________________
```

```
Along Main Stream number: 1 in normal stream number 2
Stream flow area =      0.710(Ac.)
Runoff from this stream =      2.066(CFS)
Time of concentration =    6.02 min.
Rainfall intensity =     3.006(In/Hr)
Summary of stream data:

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


1        1.084      7.93                 2.638
2        2.066      6.02                 3.006
Largest stream flow has longer or shorter time of concentration
Qp =      2.066 + sum of
          Qa          Tb/Ta
           1.084 *    0.760 =      0.823
Qp =      2.889

Total of 2 streams to confluence:
Flow rates before confluence point:
       1.084       2.066
Area of streams before confluence:
        0.460        0.710
Results of confluence:
Total flow rate =      2.889(CFS)
Time of concentration =     6.020 min.
Effective stream area after confluence =      1.170(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      205.000 to Point/Station      207.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________________
Upstream point/station elevation =  1290.400(Ft.)
Downstream point/station elevation =  1290.000(Ft.)
Pipe length  =   123.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     2.889(CFS)
Nearest computed pipe diameter  =     15.00(In.)
Calculated individual pipe flow  =     2.889(CFS)
Normal flow depth in pipe =   10.01(In.)
Flow top width inside pipe =   14.14(In.)
Critical Depth =    8.19(In.)
Pipe flow velocity =      3.32(Ft/s)
Travel time through pipe =    0.62 min.
Time of concentration (TC) =     6.64 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      205.000 to Point/Station      207.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =      1.170(Ac.)
Runoff from this stream =      2.889(CFS)
Time of concentration =    6.64 min.
Rainfall intensity =     2.870(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      206.000 to Point/Station      207.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________________
Initial area flow distance =   246.000(Ft.)
Top (of initial area) elevation =  1296.300(Ft.)
Bottom (of initial area) elevation =  1290.000(Ft.)
Difference in elevation =     6.300(Ft.)
Slope =    0.02561  s(percent)=       2.56
TC = k(0.300)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =    5.647 min.
Rainfall intensity =      3.099(In/Hr) for a    10.0 year storm
```

```
COMMERCIAL subarea type
Runoff Coefficient = 0.885
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2)  =  69.00
Pervious area fraction =  0.100; Impervious fraction =  0.900
Initial subarea runoff =      2.469(CFS)
Total initial stream area =        0.900(Ac.)
Pervious area fraction = 0.100


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      206.000 to Point/Station      207.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________________
Along Main Stream number: 1 in normal stream number 2
Stream flow area =      0.900(Ac.)
Runoff from this stream =      2.469(CFS)
Time of concentration =    5.65 min.
Rainfall intensity =     3.099(In/Hr)
Summary of stream data:

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


1        2.889      6.64                 2.870
2        2.469      5.65                 3.099
Largest stream flow has longer time of concentration
Qp =      2.889 + sum of
          Qb         Ia/Ib
           2.469 *    0.926 =      2.287
Qp =      5.176

Total of 2 streams to confluence:
Flow rates before confluence point:
       2.889       2.469
Area of streams before confluence:
        1.170        0.900
Results of confluence:
Total flow rate =      5.176(CFS)
Time of concentration =     6.637 min.
Effective stream area after confluence =      2.070(Ac.)
End of computations, total study area =            2.07 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.

Area averaged pervious area fraction(Ap) = 0.100
Area averaged RI index number =  68.9
```

APPENDIX C: HYDRAULIC CALCULATIONS

APPENDIX C.1: U-CHANNEL NORMAL DEPTH CALCULATION

Worksheet for U-CHANNEL-PROJECT BOUNDARY

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.005	
Channel Slope	0.00500	ft/ft
Bottom Width	2.00	ft
Discharge	8.18	ft^3/s

Results

Normal Depth	0.43	ft
Flow Area	0.86	ft^2
Wetted Perimeter	2.86	ft
Hydraulic Radius	0.30	ft
Top Width	2.00	ft
Critical Depth	0.80	ft
Critical Slope	0.00086	ft/ft
Velocity	9.46	ft/s
Velocity Head	1.39	ft
Specific Energy	1.82	ft
Froude Number	2.54	
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
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.43	ft
Critical Depth	0.80	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.00086	ft/ft

APPENDIX C.2: STORM DRAIN NORMAL DEPTH CALCULATIONS

Worksheet for LINE A-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	4.42	ft^3/s

Results

Normal Depth	0.83	ft
Flow Area	1.01	ft^2
Wetted Perimeter	2.52	ft
Hydraulic Radius	0.40	ft
Top Width	1.49	ft
Critical Depth	0.81	ft
Percent Full	55.5	%
Critical Slope	0.00556	ft/ft
Velocity	4.38	ft/s
Velocity Head	0.30	ft
Specific Energy	1.13	ft
Froude Number	0.94	
Maximum Discharge	7.99	ft^3/s
Discharge Full	7.43	ft^3/s
Slope Full	0.00177	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	55.54	%
Downstream Velocity	Infinity	ft/s

Worksheet for LINE A-REACH 1

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.83	ft
Critical Depth	0.81	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.00556	ft/ft

Worksheet for LINE A-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	1.68	ft^3/s

Results

Normal Depth	0.49	ft
Flow Area	0.49	ft^2
Wetted Perimeter	1.81	ft
Hydraulic Radius	0.27	ft
Top Width	1.40	ft
Critical Depth	0.49	ft
Percent Full	32.3	%
Critical Slope	0.00492	ft/ft
Velocity	3.40	ft/s
Velocity Head	0.18	ft
Specific Energy	0.66	ft
Froude Number	1.01	
Maximum Discharge	7.99	ft^3/s
Discharge Full	7.43	ft^3/s
Slope Full	0.00026	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	32.34	%
Downstream Velocity	Infinity	ft/s

Worksheet for LINE A-REACH 2

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.49	ft
Critical Depth	0.49	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.00492	ft/ft

Worksheet for LAT A

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	3.19	ft^3/s

Results

Normal Depth	0.69	ft
Flow Area	0.79	ft^2
Wetted Perimeter	2.23	ft
Hydraulic Radius	0.35	ft
Top Width	1.49	ft
Critical Depth	0.68	ft
Percent Full	45.8	%
Critical Slope	0.00518	ft/ft
Velocity	4.04	ft/s
Velocity Head	0.25	ft
Specific Energy	0.94	ft
Froude Number	0.98	
Maximum Discharge	7.99	ft^3/s
Discharge Full	7.43	ft^3/s
Slope Full	0.00092	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	45.80	%
Downstream Velocity	Infinity	ft/s

Worksheet for LAT A

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.69	ft
Critical Depth	0.68	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.00518	ft/ft

Worksheet for LINE B

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00500	ft/ft
Diameter	2.00	ft
Discharge	8.02	ft^3/s

Results

Normal Depth	1.00	ft
Flow Area	1.57	ft^2
Wetted Perimeter	3.15	ft
Hydraulic Radius	0.50	ft
Top Width	2.00	ft
Critical Depth	1.01	ft
Percent Full	50.1	%
Critical Slope	0.00489	ft/ft
Velocity	5.09	ft/s
Velocity Head	0.40	ft
Specific Energy	1.41	ft
Froude Number	1.01	
Maximum Discharge	17.21	ft^3/s
Discharge Full	16.00	ft^3/s
Slope Full	0.00126	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	50.09	%
Downstream Velocity	Infinity	ft/s

Worksheet for LINE B

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	1.00	ft
Critical Depth	1.01	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.00489	ft/ft

APPENDIX C.3: CATCH BASIN CALCULATIONS

Worksheet for CATCH BASIN #1

Project Description

Solve For	Efficiency

Input Data

Discharge	1.68	ft³/s
Slope	0.01600	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.06	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.015	
Curb Opening Length	7.00	ft
Local Depression	4.00	in
Local Depression Width	4.00	ft

Results

Efficiency	83.90	%
Intercepted Flow	1.41	ft³/s
Bypass Flow	0.27	ft³/s
Spread	6.86	ft
Depth	0.22	ft
Flow Area	0.56	ft²
Gutter Depression	0.09	ft
Total Depression	0.42	ft
Velocity	3.02	ft/s
Equivalent Cross Slope	0.09539	ft/ft
Length Factor	0.64	
Total Interception Length	10.98	ft

Worksheet for CATCH BASIN #2

Project Description

Solve For	Spread

Input Data

Discharge		3.19	ft^3/s
Gutter Width		4.00	ft
Gutter Cross Slope		0.06	ft/ft
Road Cross Slope		0.02	ft/ft
Curb Opening Length		4.00	ft
Opening Height		0.58	ft
Curb Throat Type	Inclined		
Local Depression		4.00	in
Local Depression Width		4.00	ft
Throat Incline Angle		0.00	degrees

Results

Spread	12.42	ft
Depth	0.42	ft
Gutter Depression	0.17	ft
Total Depression	0.50	ft

APPENDIX C.4: MISSION TRAIL CONCRETE CHANNEL

Worksheet for CONCRETE CHANNEL

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00200	ft/ft
Discharge	8.02	ft³/s

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	2.50
0+04.50	0.00
0+08.50	0.00
0+08.50	2.50

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00.00, 2.50)	(0+08.50, 2.50)	0.015

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	0.64	ft
Elevation Range	0.00 to 2.50 ft	
Flow Area	2.91	ft²
Wetted Perimeter	5.95	ft
Hydraulic Radius	0.49	ft
Top Width	5.15	ft
Normal Depth	0.64	ft
Critical Depth	0.48	ft
Critical Slope	0.00505	ft/ft

Worksheet for CONCRETE CHANNEL

Results

Velocity		2.75	ft/s
Velocity Head		0.12	ft
Specific Energy		0.75	ft
Froude Number		0.64	
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
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.64	ft
Critical Depth	0.48	ft
Channel Slope	0.00200	ft/ft
Critical Slope	0.00505	ft/ft

APPENDIX D: WATER QUALITY

APPENDIX D.1: 85TH PERCENTILE RAINFALL MAP

R 07 W | R 06 W | R 05 W | R 04 W | R 03 W | R 02 W | R 01 W | R 01 E | R 02 E | R 03 E | R 04 E | R 05 E

T 01 S
T 02 S
T 03 S
T 04 S
T 05 S
T 06 S
T 07 S
T 08 S

06	05	04	03	02	01
07	08	09	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

0.85 MiraLoma
0.61 RiversideNorth
0.54 RiversideSouth
0.68 PigeonPass
0.66 MorenoEast
0.85 Beaumont
0.88 PradoDam
0.51 Woodcrest
0.50 LakeMathews
0.68 PerrisReservoir
0.87 VistaGrandeGS
0.70 SanJacintoNWS
1.18 Idyllwild
0.58 SunCity
0.68 Winchester
0.90 HurkeyCreek
0.70 ElsinoreNWS
1.11 ElCarisoStation
PROJECT SITE
0.77 WildomarLaCresta
0.52 SkinnerLake
0.65 Anza
0.77 SantaRosaPlateau
1.00 TemeculaNWS
0.64 AguangaValley

Santa Ana River Watershed
Santa Margarita Watershed

JURUPA VALLEY | EASTVALE | NORCO | CORONA | RIVERSIDE | MORENO VALLEY | CALIMESA | BEAUMONT | SAN JACINTO | PERRIS | CANYON LAKE | LAKE ELSINORE | WILDOMAR | MENIFEE | HEMET | MURRIETA | TEMECULA

N

Rain Gage Locations

RIVERSIDE COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT

Isohyetal Map for the 85th Percentile 24 hour Storm Event

July 2011

APPENDIX D.2: BMP DESIGN VOLUME SPREADSHEETS

Santa Margarita Watershed

BMP Design Volume, V_{BMP} (Rev. 03-2012)

Legend: Required Entries / Calculated Cells

(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)

Company Name	JLC Engineering	Date	6/4/2019
Designed by	CRC	County/City Case No	
Company Project Number/Name	KCG Blue		
Drainage Area Number/Name	DMA A		

Enter the Area Tributary to this Feature A_T = 2.07 acres

85th Percentile, 24-hour Rainfall Depth, from the Isohyetal Map in Handbook Appendix E

Site Location

Township: 6S

Range: 4W

Section: 27

Enter the 85th Percentile, 24-hour Rainfall Depth D_{85} = 0.72

Determine the Effective Impervious Fraction

Type of post-development surface cover (use pull down menu): Mixed Surface Types

Effective Impervious Fraction I_f = 0.91

Calculate the composite Runoff Coefficient, C for the BMP Tributary Area

Use the following equation based on the WEF/ASCE Method

$C = 0.858I_f^3 - 0.78I_f^2 + 0.774I_f + 0.04$

C = 0.74

Determine Design Storage Volume, V_{BMP}

Calculate V_U, the 85% Unit Storage Volume $V_U = D_{85} \times C$

V_u = 0.54 (in*ac)/ac

Calculate the design storage volume of the BMP, V_{BMP}.

$$V_{BMP}\ (ft^3) = \frac{V_U\ (in\text{-}ac/ac) \times A_T\ (ac) \times 43{,}560\ (ft^2/ac)}{12\ (in/ft)}$$

V_{BMP} = 4,058 ft^3

Notes:

APPENDIX D.3: BIOFILTRATION WITH PARTIAL INFILTRATION FACILITY DESIGN PROCEDURE SPREADSHEET

Biofiltration with Partial Infiltration Facility - Design Procedure	BMP ID: A	Legend:	Required Entries / Calculated Cells
Company Name:	JLC Engineering	Date:	6/4/2019
Designed by:	Jilleen Ferris	County/City Case No.:	KCG

Design Volume

Enter the area tributary to this feature	A_T =	2.07	acres
Enter V_{BMP} determined from Section 2.1 of this Handbook	V_{BMP} =	4,058	ft^3
Enter initial estimate of footprint of BMP, $Area_{BMP}$ (Guidance: A reasonable starting point is 3% of the tributary impervious area)	$Area_{BMP}$ =	1,863	ft^2

Note: This area shall be measured at the mid-ponding depth of the BMP. For systems with side-slopes, this should be the contour that is midway between the floor of the basin and the maximum water quality ponding elevation of the basin. The underlying gravel layer (infiltration storage layer) should extend to this contour. For systems with vertical walls, the effective area is the full footprint.

Portion of DCV Reliably Retained

Depth of Gravel Infiltration Storage Layer (18" minimum; 30" maximum)	dg =	18.0	inches
Portion of V_{BMP} Reliably Retained via Infiltration Storage in Gravel Layer $V_{retained} = d_g\,(in) \times 0.4 \times Area_{BMP}\,(ft^2) \times 1/12$	$V_{Retained}$ =	1117.8	ft^3
Portion of V_{BMP} not Reliably Retained $V_{Not\ Reliably\ Retained} = V_{BMP} - V_{Retained}$	$V_{Not\ Reliably\ Retained}$ =	2940.2	ft^3

Biofiltration with Partial Retention Facility Surface Area

Depth of Surface Ponding Layer (6" minimum, 12" maximum)	d_P =	6.0	inches
Depth of Engineered Soil Media (24" to 36"; 18" if vertically constrained)	d_S =	36.0	inches
Design Media Filtration Rate (2.5 in/hr)	I_{design} =	2.5	in/hr
Allowable Routing Period, $T_{routing}$ (5 hrs)	$T_{routing}$ =	5.0	hr
Effective Biofiltration Depth, d_{E_bio} $d_{E\_bio}\,(ft) = (d_P + (0.3 \times d_S) + (I_{design} * T_{routing}))\,(ft)$	d_{E_bio} =	2.4	ft
Effective Static Depth, $d_{E\_bio\_static}$ $d_{E\_bio\_static} = (d_P + (0.3 * d_S))\,(ft)$	$d_{E\_bio\_static}$ =	1.4	ft
$V_{biofiltered} = d_{E\_bio} * Area_{BMP}$	$V_{biofiltered}$ =	4548.8	ft^3
$V_{biofiltered\_static} = d_{E\_bio\_static} * Area_{BMP}$	$V_{biofiltered\_static}$ =	2608.2	ft^3

Sizing Option 1 Result

Criteria 1:	$V_{biofiltered\ (with\ routing)} > 150\%$ of $V_{not\ reliably\ retained}$	Results: PASS

Sizing Option 2 Result

Criteria 2:	$V_{biofiltered\_static} > 0.75 \times V_{Not\ Reliably\ Retained}$	Results: PASS

Note

If neither of these criteria are met, then increase retention depth, increase footprint, or both, and rerun calculations. This calculation is inherently iterative.

Biofiltration with Partial Retention Facility Properties

Side Slopes in Partial Retention with Biofiltration Facility	z = 4	:1
Diameter of Underdrain	6	inches
Longitudinal Slope of Site (3% maximum)	1.1	%
Check Dam Spacing	0	feet
Describe Vegetation:		

Notes:

EXHIBITS

EXHIBIT A: PRE-PROJECT CONDITION RATIONAL METHOD HYDROLOGY MAP

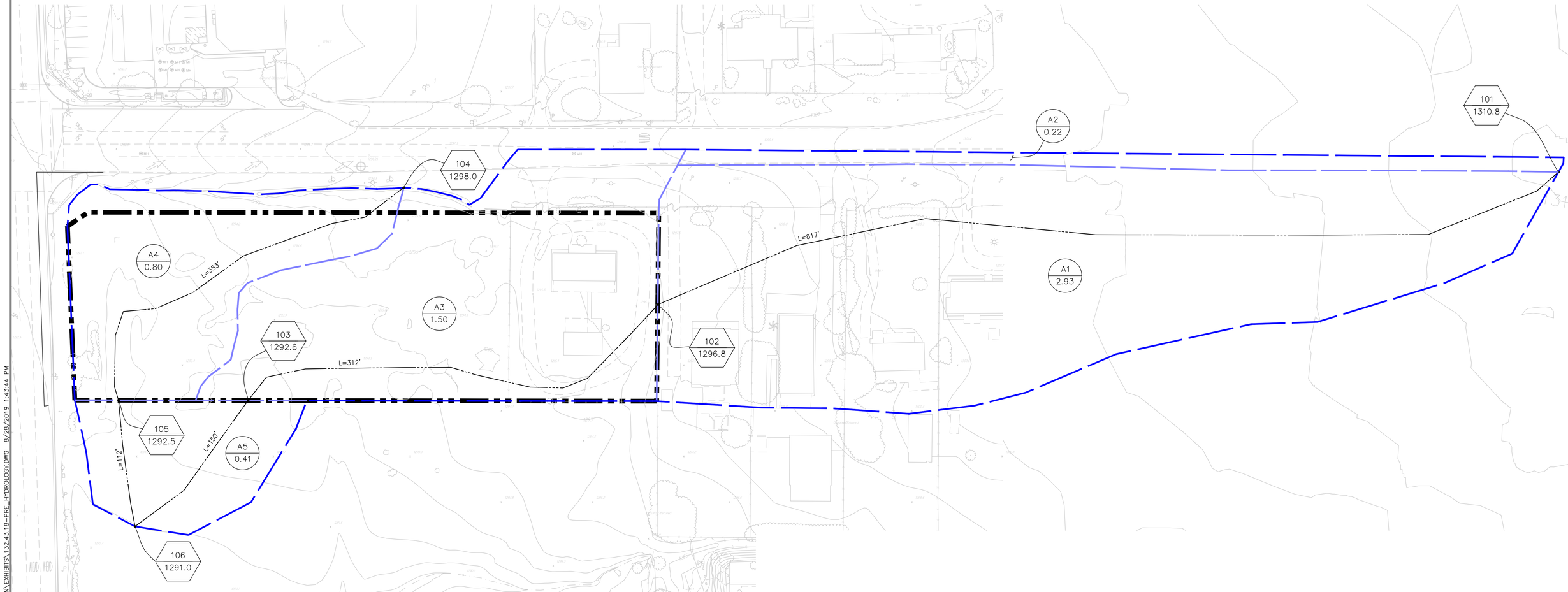
KGC BLUE SHOOTING RANGE

IN THE CITY OF WILDOMAR, COUNTY OF RIVERSIDE, STATE OF CALIFORNIA

PRE-PROJECT RATIONAL METHOD HYDROLOGY MAP

LEGEND:

- WATERSHED BOUNDARY
- SUBAREA BOUNDARY
- FLOW PATH
- L=XXX' — LENGTH OF WATERCOURSE
- XXX / XXXX.X / XX.XX — NODE/CONCENTRATION POINT / FLOWLINE ELEVATION
- X-XX / X.X — SUBAREA / ACREAGE



GRAPHIC SCALE
30' 0 15' 30' 60'
1" = 30'

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

EXHIBIT "A"

KGC BLUE

PRE-PROJECT RATIONAL METHOD HYDROLOGY MAP

EXHIBIT B: POST-PROJECT CONDITION RATIONAL METHOD HYDROLOGY MAP

KCG BLUE SHOOTING RANGE

IN THE CITY OF WILDOMAR, COUNTY OF RIVERSIDE, STATE OF CALIFORNIA

POST-PROJECT RATIONAL METHOD HYDROLOGY MAP

LEGEND:

- WATERSHED BOUNDARY
- SUBAREA BOUNDARY
- FLOW PATH
- STORM DRAIN
- L=XXX' — LENGTH OF WATERCOURSE
- XXX / XXXX.X / XX.XX — NODE/CONCENTRATION POINT / FLOWLINE ELEVATION
- X-XX / X.X — SUBAREA / ACREAGE

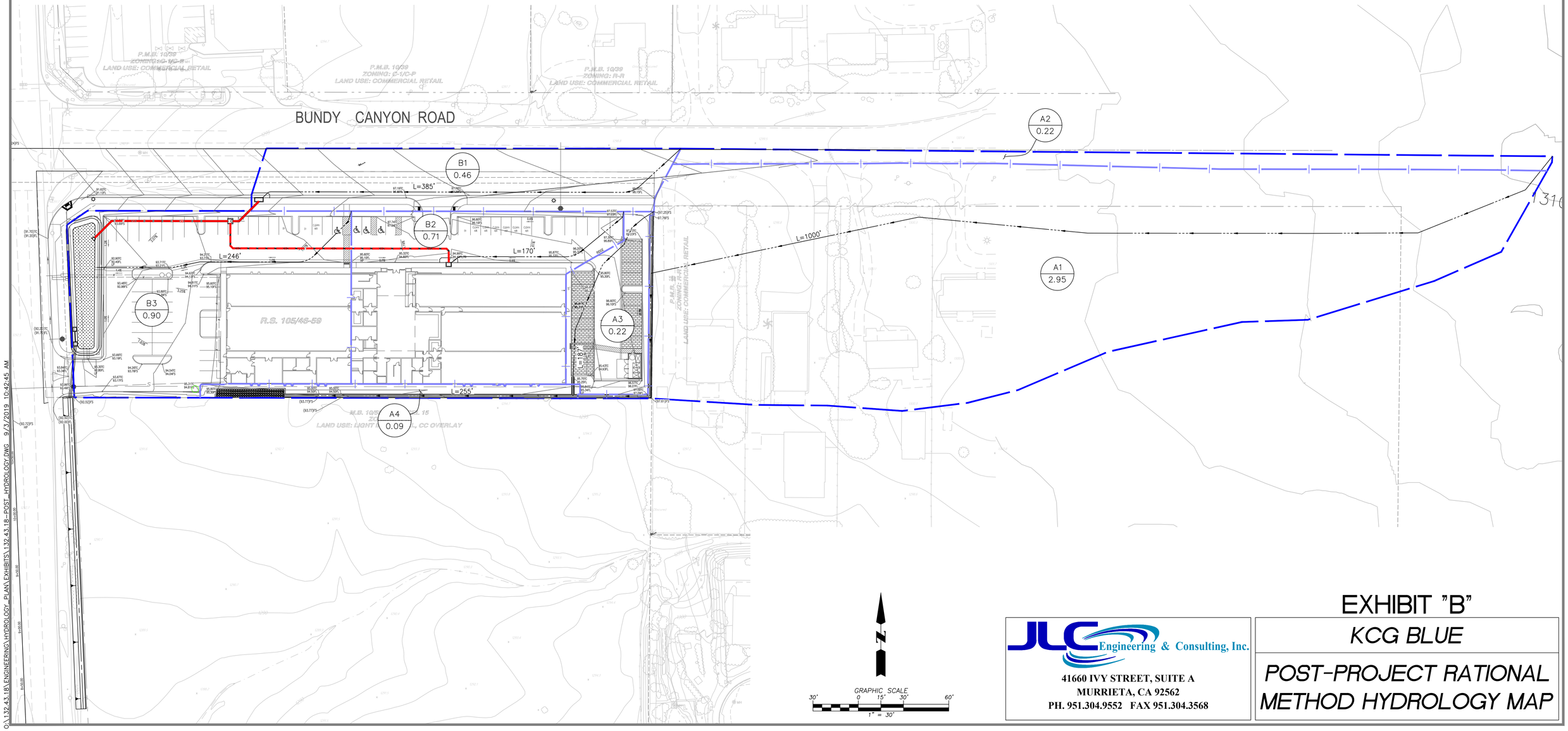


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EXHIBIT "B"

KCG BLUE

POST-PROJECT RATIONAL METHOD HYDROLOGY MAP

EXHIBIT C: DRAINAGE FACILITIES MAP

KCG BLUE SHOOTING RANGE

IN THE CITY OF WILDOMAR, COUNTY OF RIVERSIDE, STATE OF CALIFORNIA

DRAINAGE FACILITIES MAP

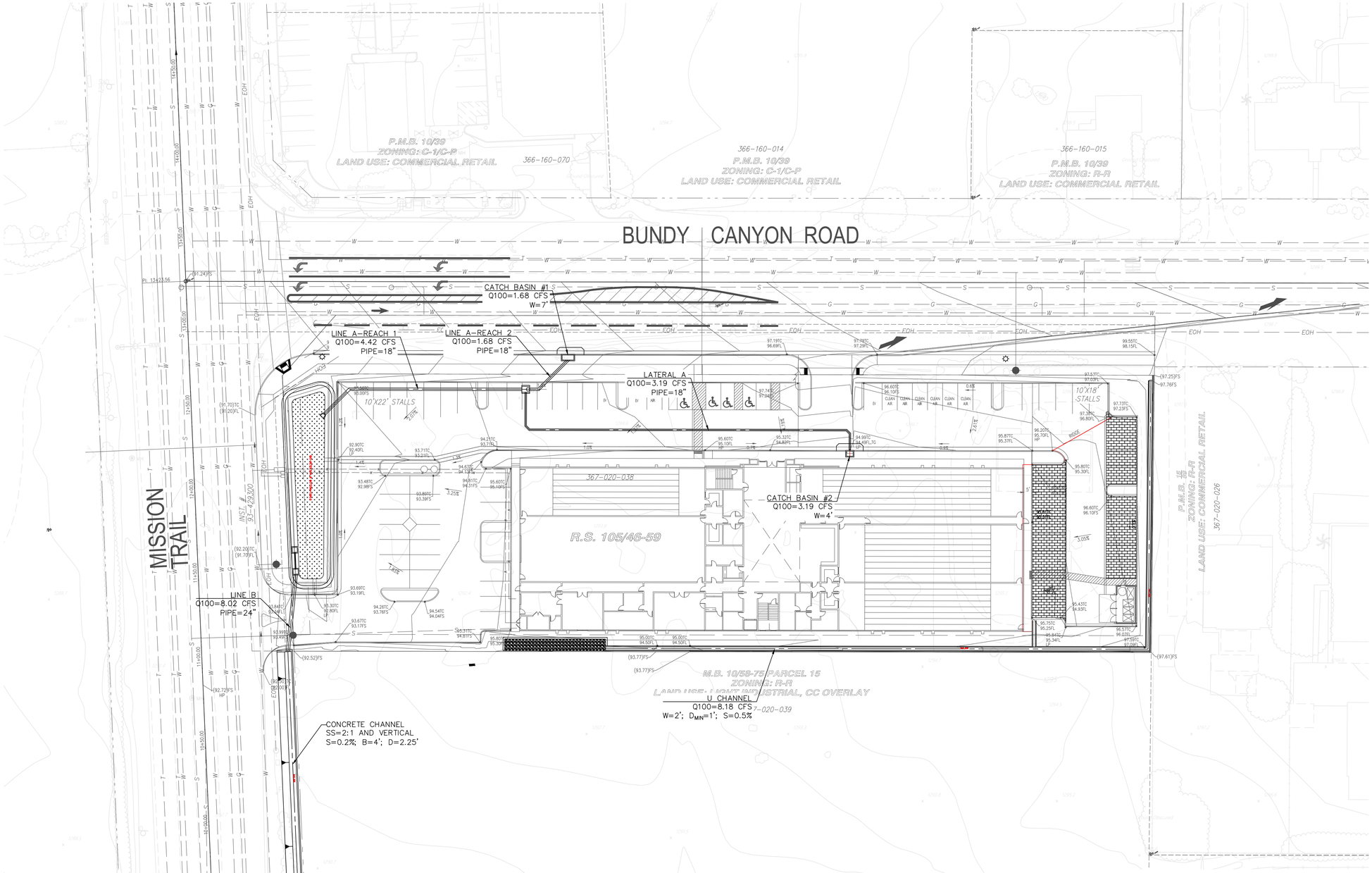

EXHIBIT "C"

KCG BLUE

DRAINAGE FACILITIES SITE HYDROLOGY MAP

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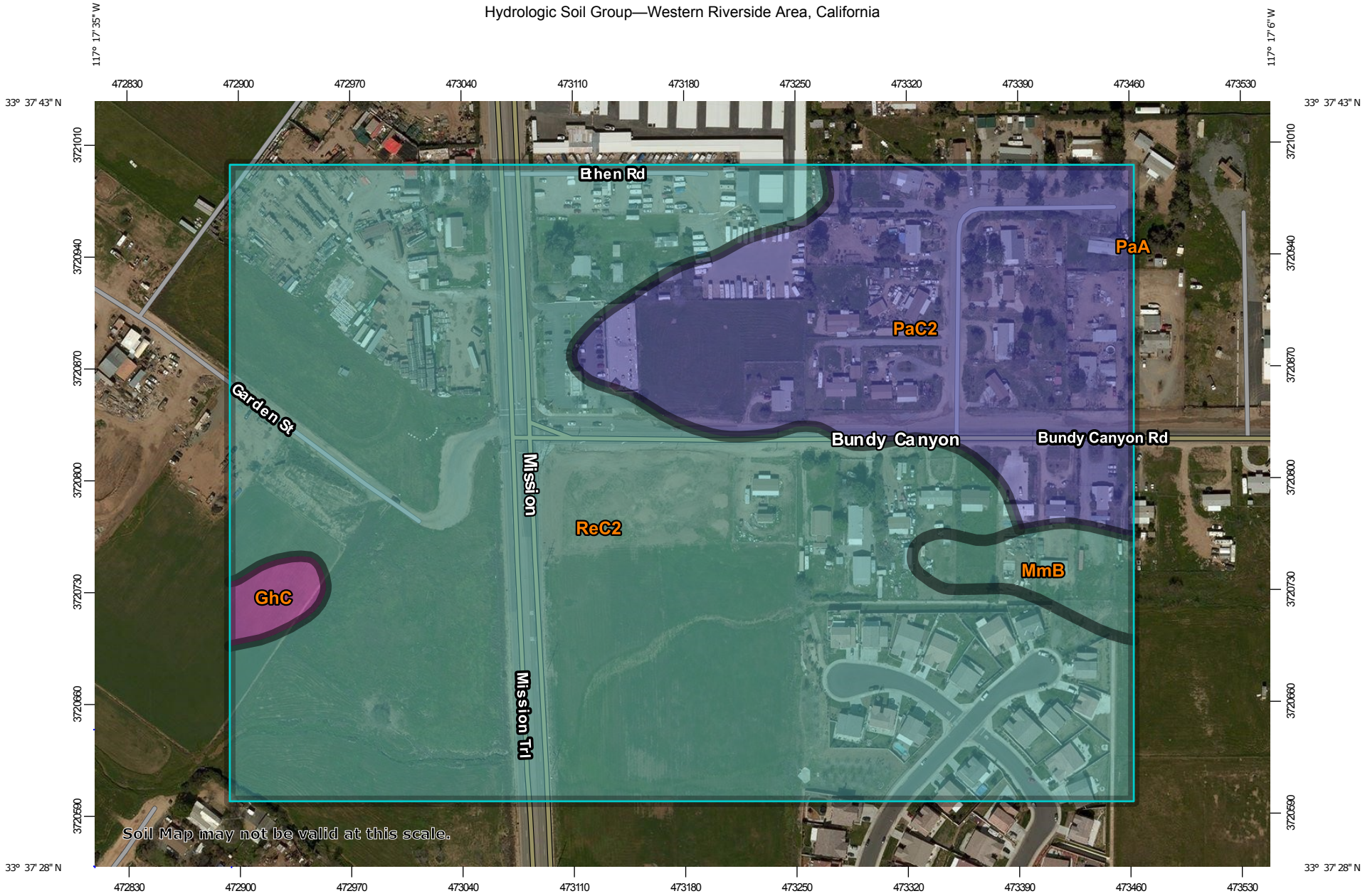
Drawing Name: O:\132_43.18\Engineering\Hydrology_Plan\Exhibits\Drainage Facilities Map.dwg
Last Operated: Sep 02, 2019 - 11:22am by jparker

EXHIBIT D: HYDROLOGIC SOILS MAP



Map Scale: 1:3,380 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 50 100 200 300

Feet: 0 150 300 600 900

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 1:15,800.

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: Western Riverside Area, California
Survey Area Data: Version 11, Sep 12, 2018

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

Date(s) aerial images were photographed: May 25, 2010—Feb 26, 2015

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
GhC	Gorgonio loamy sand, 0 to 8 percent slopes	A	0.6	1.1%
MmB	Monserate sandy loam, 0 to 5 percent slopes	C	1.5	2.7%
PaA	Pachappa fine sandy loam, 0 to 2 percent slopes	B	0.0	0.0%
PaC2	Pachappa fine sandy loam, 2 to 8 percent slopes, eroded	B	13.2	23.6%
ReC2	Ramona very fine sandy loam, 0 to 8 percent slopes, eroded	C	40.8	72.7%
Totals for Area of Interest			**56.2**	**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

EXHIBIT E: RAINFALL MAPS

PROJECT SITE
2-YEAR = 0.63 in.

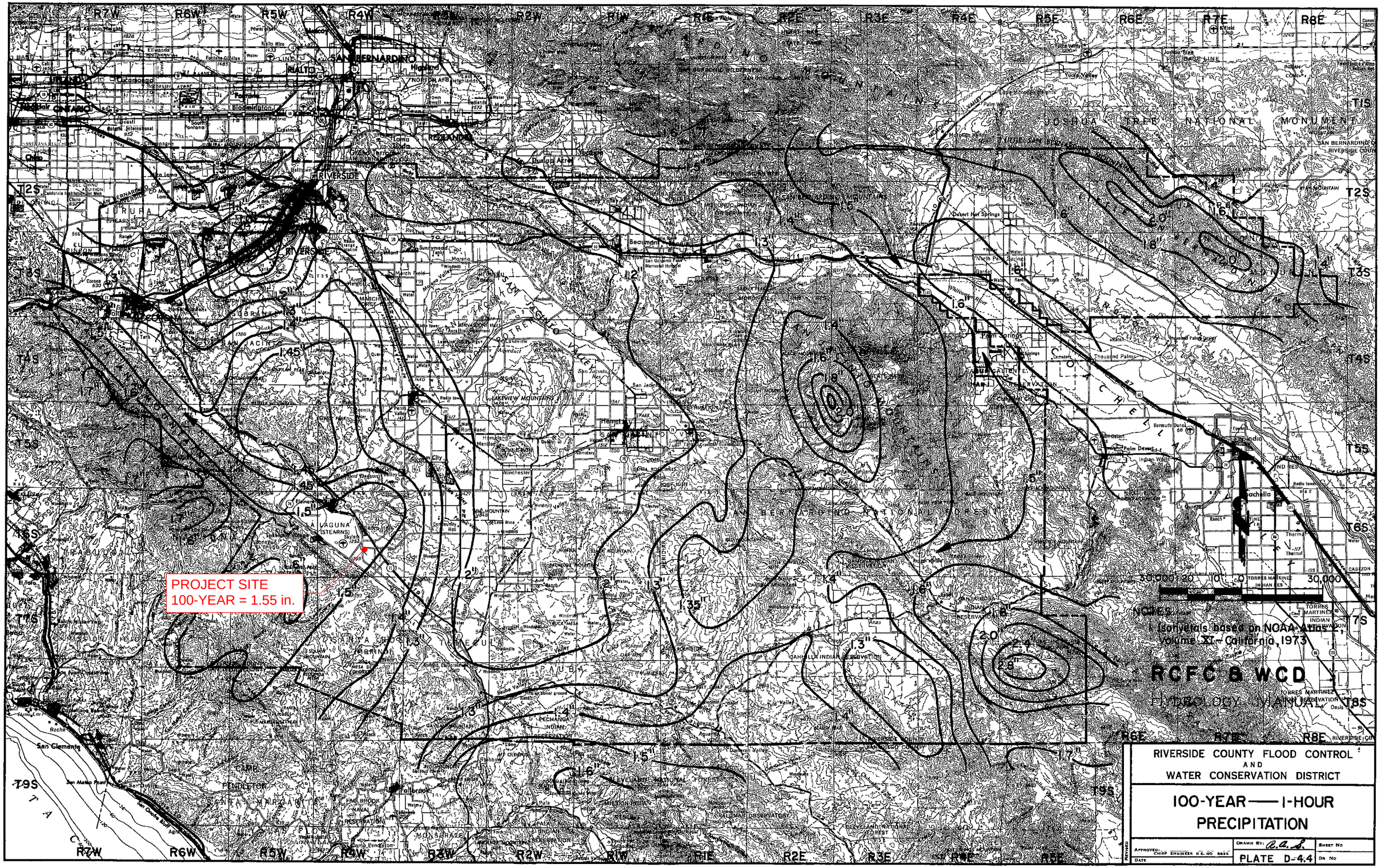
NOTES:
1. Isohyetals based on NOAA Atlas 2, Volume XI - California, 1973

RCFC & WCD
HYDROLOGY MANUAL

RIVERSIDE COUNTY FLOOD CONTROL
AND
WATER CONSERVATION DISTRICT

2-YEAR — 1-HOUR
PRECIPITATION

APPROVED _____ CHIEF ENGINEER R.E. NO. 8882
DATE _____
DRAWN BY R.A.S.
PLATE D-4.3
SHEET NO
DR NO


PROJECT SITE
100-YEAR = 1.55 in.
NOTES:
1. Isohyetals based on NOAA Atlas 2, volume XI - California, 1973
RCFC & WCD
HYDROLOGY MANUAL
RIVERSIDE COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT
100-YEAR — 1-HOUR PRECIPITATION
DRAWN BY: A.A.S.
PLATE D-4.4

PROJECT SITE
Slope of Intensity = 0.475

NOTES
1. Slope of Intensity-Duration Curve based on District analysis of automatic recording rain gage records

RCFC & WCD
HYDROLOGY MANUAL

RIVERSIDE COUNTY FLOOD CONTROL
AND
WATER CONSERVATION DISTRICT

SLOPE OF INTENSITY DURATION CURVE

APPROVED CHIEF ENGINEER R.E. NO. 8824	DRAWN BY	SHEET NO
DATE	PLATE D-4.6	DR NO