

DRAINAGE STUDY FOR:

**Plot Plan No. 26225,
Revised Permit No. 1,
(PP26225R01)**

County of Riverside, CA

PTS NO. TBD

I.O. NO. TBD

DWG. NO. TBD

June 8, 2023

Prepared for:

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I. PROJECT DESCRIPTION

The project is an existing winery that will expand the building footprint to include, but not limited to, a tasting room, wine storage areas, and designated office space. The improvements will add 5,250 sqft of impervious surface that make up the expanded building. The project is in the County of Riverside, north off of the major street intersection of Nicholas Valley Road/Camino Contento and Rancho California Road, on the east side of Camino Contento. The project is bound by neighboring wineries on the projects north and east side, and Camino Contento on the westerly boundary. The parcel measures approximately 19.4 Ac and is designated as APN 943-210-012, referred thereafter as the Akash Winery.

The enclosed hydrology report analyzes the 100-year storm event hydrology for the existing and proposed condition of the study area that includes the expanded building footprint, dirt/DG driveway on the northeast side of the project and hillside drainage that is routed around the development area. Project flow rates and time of concentration were determined and compared. Drainage facilities, where applicable, were analyzed for their hydraulic capacity and document in Appendix B. Additionally, overflow riser calculations were included to ensure the proposed underground basins, which is part of the project water quality management plan, was sufficiently sized. Please refer to the map pockets: Proposed Condition Hydrology Map for an overview of the project drainage pattern. Additionally, please refer to the WQMP Exhibit referenced in this report, for the layout of the proposed drainage facilities that convey the water quality storm flows.

II. EXISTING SITE CONDITION DRAINAGE

Referring to Existing Condition Hydrology Map in the map book section of this report, the drainage generally flows southwest. The existing terrain has various slopes, with an average slope of 10%. The USDA Natural Resources Conservation Services identifies the project as having a mixed hydrologic soil classification of Soil Class A and C, which can be referenced in Appendix C. Soil A is characterized as a site with low runoff potential and a high infiltration capacity. The study area mostly falls under Class A soil. For that reason, soil type A was used for the hydrology analysis.

The existing condition hydrology represents the disturbed areas and hillside contributing flow that is diverted around the development area. The existing drainage area land use varies, since it is currently partially developed, but for the purpose of this report, the project is assumed undisturbed in the existing condition. Please refer to the map pockets: Existing Condition Hydrology Map, where the overall project drainage pattern is delineated.

III. DEVELOPED SITE CONDITION DRAINAGE

As mentioned in the introduction, the project is an existing winery that will expand the building footprint of the tasting room to include additional seating and shade structure on the northeast face. Additional improvements include a private decomposed granite driveway leading up to the open space that currently acts as a parking area. Engineered grading is also proposed on the northeast side of the project, as well as storm drain infrastructure improvements that are used to divert hillside drainage around the project development. Drainage continues to follow the existing condition flow path draining southeast.

The study area for the developed condition is analyzed using 5 subareas that include the onsite improvement area, hillside drainage and existing open space that is described as an unpaved parking area. Specifically, the areas are described as follows:

Area A1 is defined as the study area containing the roof drainage of the existing building and proposed building expansion that runs down through roof drains and into an underground stormtech chamber. Study area A2 describes the drainage area with the decomposed granite driveway and the existing impervious parking area. Drainage for this sub area drains down the proposed driveway and into catch basins that drain into an underground stormtech chamber located on the west side of the driveway. Area A3 includes existing impervious areas from the outdoor patio area, concrete areas, and existing restroom. Drainage here flows south towards the underground storm chamber A3. Area B1 describes the unpaved parking area that drains water towards an existing storm drain line, which will be retrofitted to include additional inlets to insure proper drainage to the facility. Area B2 describes the hillside drainage that is to be routed around the development area and piped northwest to the existing vineyards.

Please refer to the map pockets: Proposed Condition Hydrology Map, where the overall project drainage pattern is delineated.

IV. HYDROLOGIC METHODOLOGY

The overall drainage basin of study covers approximately 17.33 acres. To determine the drainage areas for the site, a survey was done for the project, where contours were generated and used for the design of the proposed project. Once the site was designed, tributary areas for the existing condition and proposed condition were delineated. The Riverside County Hydrology Manual's Rational Method Procedure was the basis for the proposed condition 100-Year hydrologic analysis. The rational method input parameters used included an AMC of 3 and Land Use, which was modeled based on the percent impervious for the site and the default values in Plate D-5.6 Impervious Cover for Developed Areas. Land use modeled in this report for the existing condition is Undeveloped Condition with poor cover at 0% impervious. For the developed condition, Commercial, ¼ Acre Residential, Condominium and Undeveloped Condition with poor cover were used and have an impervious fraction of 90%, 50%, 65% and 0% respectively. The rational method procedure follows Plate D-1 of the Riverside County Hydrology Manual. Please refer to Appendix A for the full hydrology analysis.

V. HYDRAULIC METHODOLOGY

Drainage facilities that require hydraulic analysis for the project are the various storm drain lines throughout the site and the proposed risers for each basin. The facilities are preliminarily designed using excel spreadsheets, using Manning's N formula to conduct the capacity calculations. For Channel A, the Hydraulics was performed using Hydraulic Toolbox by FHWA, which is also based on Manning's N trapezoidal channel inputs. These facilities will be designed in detail during final engineering and will be referenced in Appendix B. Preliminary calculations are provided for site planning.

VII. DISCUSSION AND RESULT

Table 1: Rational Method Analysis Summary Table

Condition	Drainage Area ID	Area (ac)	Q100 (cfs)
Existing Condition	1A	7.33	17.18
Proposed Condition	1A-3A	7.33	19.46

Upon review of the hydrologic calculations and above summary table, the 100-year flow shows an increase from existing condition. This was expected, due to the small increase in impervious area introduced to the site. While there is a negligible increase in 100-year flows, storm events up to the 10-year will mostly be mitigated through proposed structural BMPs, as concluded in the project WQMP. That said, the project has been designed to convey onsite drainage safely away from the project critical infrastructure and will convey drainage safely away from the project. Please see the enclosed hydrology report supporting the conclusions hereon.

APPENDIX A: HYDROLOGIC CALCULATIONS

Rational Method Hydrology Analysis

- 100 Year Existing Condition Rational Method – Area 1A
- 100 Year Proposed Condition Rational Method – Area 1A-3A, 1B-2B

Riverside County Rational Method Hydrology - 100-Year Design Storm

Calculation Based on Riverside County Hydrology Manual, April 1978

Project Name: Akash Winery
Project Location: County of Riverside

Input
Calculated

Sub Area 1A - Pre-Development - Hydrology Information				Hydrology Manual Reference Values						
Drainage Area (Acres) - 10 Acres Maximum	7.33	2-Year, 1-Hour Intensity (In/Hr) - Plate D-4.3	0.5							
Longest Watercourse (Ft) - 1,000' Maximum	900	100-Year, 1-Hour Intensity (In/Hr) - Plate D-4.1	1.2							
Upstream Elevation Of Watercourse (Ft)	1406	Slope Of The Intensity Duration - Plate D-4.6	0.55							
Downstream Elevation Of Watercourse (Ft)	1302.7	Impervious Percentage (% Plate D-5.6)	0% Undeveloped - Poor Cover							
Existing Impervious Percentage (%)	0	AMC	3							
0.1Q2										
Pre-Development - Soils Information										
Area ID	Subarea Acreage	Cover Type	Vegetative Cover	Soil A %	Soil B %	Soil C %	Soil D %	RI Index AMC I	RI Index AMC II	RI Index AMC III
1A	7.33 Ac.	Grass	Poor Cover	100				47	67	83
								0	0	0
								0	0	0
Total= 7.33 Ac.		Weighted Average RI =						47 Ac.	67 Ac.	83.0
Sub Area 1A - Pre Condition Summary										
100-year Flowrate =		17.18	cfs							
Tc, Min=		12.42	min							
100yr Peak Intensity (for drainage area) =		2.85	in/hr							
Runoff Coefficient (100-year) =		0.82								

Riverside County Rational Method Hydrology - 100-Year Design Storm

Calculation Based on Riverside County Hydrology Manual, April 1978

Project Name: Akash Winery
Project Location: County of Riverside

Input
Calculated

Sub Area 1A - Post-Development - Hydrology Information				Hydrology Manual Reference Values						
Drainage Area (Acres) - 10 Acres Maximum	0.28	2-Year, 1-Hour Intensity (In/Hr) - Plate D-4.3	0.5							
Longest Watercourse (Ft) - 1,000' Maximum	135	100-Year, 1-Hour Intensity (In/Hr) - Plate D-4.1	1.2							
Upstream Elevation Of Watercourse (Ft)	1309	Slope Of The Intensity Duration - Plate D-4.6	0.55							
Downstream Elevation Of Watercourse (Ft)	1306.3	Impervious Percentage	90% Commercial							
Proposed Impervious Percentage (%)	90	AMC	3							
				0.1Q2						
Post-Development - Soils Information										
Area ID	Subarea Acreage	Cover Type	Vegetative Cover	Soil A %	Soil B %	Soil C %	Soil D %	RI Index AMC I	RI Index AMC II	RI Index AMC III
1A	0.28 Ac.	Urban Landscaping	Good Cover	100				16	32	52
								0	0	0
								0	0	0
Total= 0.28 Ac.		Weighted Average RI =						16 Ac.	32 Ac.	52.0
Sub Area 1A - Post Condition Summary										
100-year Flowrate =		1.21	cfs							
Tc, Min=		4.67	min							
100yr Peak Intensity (for drainage area) =		4.89	in/hr							
Runoff Coefficient (100-year) =		0.88								

Sub Area 2A - Post-Development - Hydrology Information				Hydrology Manual Reference Values						
Drainage Area (Acres) - 10 Acres Maximum	0.99	2-Year, 1-Hour Intensity (In/Hr) - Plate D-4.3	0.5							
Longest Watercourse (Ft) - 1,000' Maximum	295	100-Year, 1-Hour Intensity (In/Hr) - Plate D-4.1	1.2							
Upstream Elevation Of Watercourse (Ft)	1325.7	Slope Of The Intensity Duration - Plate D-4.6	0.55							
Downstream Elevation Of Watercourse (Ft)	1302.7	Impervious Percentage	50% 1/4 Acre Residential							
Proposed Impervious Percentage (%)	50	AMC	3							
				0.1Q2						
Post-Development - Soils Information										
Area ID	Subarea Acreage	Cover Type	Vegetative Cover	Soil A %	Soil B %	Soil C %	Soil D %	RI Index AMC I	RI Index AMC II	RI Index AMC III
1A	0.99 Ac.	Urban Landscaping	Good Cover	100				16	32	52
								0	0	0
								0	0	0
Total= 0.99 Ac.		Weighted Average RI =						16 Ac.	32 Ac.	52.0
Sub Area 2A - Post Condition Summary										
100-year Flowrate =		3.26	cfs							
Tc, Min=		6.32	min							
100yr Peak Intensity (for drainage area) =		4.14	in/hr							
Runoff Coefficient (100-year) =		0.80								

Riverside County Rational Method Hydrology - 100-Year Design Storm

Calculation Based on Riverside County Hydrology Manual, April 1978

Project Name: Akash Winery
Project Location: County of Riverside

Input
Calculated

Sub Area 3A - Post-Development - Hydrology Information				Hydrology Manual Reference Values						
Drainage Area (Acres) - 10 Acres Maximum	1.17	2-Year, 1-Hour Intensity (In/Hr) - Plate D-4.3	0.5							
Longest Watercourse (Ft) - 1,000' Maximum	515	100-Year, 1-Hour Intensity (In/Hr) - Plate D-4.1	1.2							
Upstream Elevation Of Watercourse (Ft)	1331	Slope Of The Intensity Duration - Plate D-4.6	0.55							
Downstream Elevation Of Watercourse (Ft)	1296	Impervious Percentage	65% Condominiums							
Proposed Impervious Percentage (%)	65	AMC	3							
				0.102						
Post-Development - Soils Information										
Area ID	Subarea Acreage	Cover Type	Vegetative Cover	Soil A %	Soil B %	Soil C %	Soil D %	RI Index AMC I	RI Index AMC II	RI Index AMC III
1A	1.17 Ac.	Urban Landscaping	Good Cover	100				16	32	52
								0	0	0
								0	0	0
Total= 1.17 Ac.		Weighted Average RI =						16 Ac.	32 Ac.	52.0
Sub Area 3A - Post Condition Summary				Proposed Condition Summary (Sub-Area 1A-5A)						
100-year Flowrate =		4.04 cfs		100-year Flowrate =		8.51 cfs				
Tc, Min=		6.24 min		Tc, Min=		6.32 min				
100yr Peak Intensity (for drainage area) =		4.17 in/hr		100yr Peak Intensity (for drainage area) =		4.89 in/hr				
Runoff Coefficient (100-year) =		0.83		Weight Ave. Runoff Coefficient (100-year) =		0.82				

Riverside County Rational Method Hydrology - 100-Year Design Storm

Calculation Based on Riverside County Hydrology Manual, April 1978

Project Name: Akash Winery
Project Location: County of Riverside

Input
Calculated

Sub Area 1B - Post-Development - Hydrology Information				Hydrology Manual Reference Values						
Drainage Area (Acres) - 10 Acres Maximum	2.34	2-Year, 1-Hour Intensity (In/Hr) - Plate D-4.3	0.5							
Longest Watercourse (Ft) - 1,000' Maximum	440	100-Year, 1-Hour Intensity (In/Hr) - Plate D-4.1	1.2							
Upstream Elevation Of Watercourse (Ft)	1347	Slope Of The Intensity Duration - Plate D-4.6	0.55							
Downstream Elevation Of Watercourse (Ft)	1320	Impervious Percentage	0% Undeveloped - Poor Cover							
Proposed Impervious Percentage (%)	0	AMC	3							
0.102										
Post-Development - Soils Information										
Area ID	Subarea Acreage	Cover Type	Vegetative Cover	Soil A %	Soil B %	Soil C %	Soil D %	RI Index AMC I	RI Index AMC II	RI Index AMC III
1A	2.34 Ac.	Urban Landscaping	Good Cover	100				16	32	52
								0	0	0
								0	0	0
Total= 2.34 Ac.		Weighted Average RI =						16 Ac.	32 Ac.	52.0
Sub Area 1B - Post Condition Summary										
100-year Flowrate =		4.71	cfs							
Tc, Min=		10.57	min							
100yr Peak Intensity (for drainage area) =		3.12	in/hr							
Runoff Coefficient (100-year) =		0.65								

Sub Area 2B - Post-Development - Hydrology Information				Hydrology Manual Reference Values						
Drainage Area (Acres) - 10 Acres Maximum	2.55	2-Year, 1-Hour Intensity (In/Hr) - Plate D-4.3	0.5							
Longest Watercourse (Ft) - 1,000' Maximum	365	100-Year, 1-Hour Intensity (In/Hr) - Plate D-4.1	1.2							
Upstream Elevation Of Watercourse (Ft)	1406	Slope Of The Intensity Duration - Plate D-4.6	0.55							
Downstream Elevation Of Watercourse (Ft)	1343	Impervious Percentage	0% Undeveloped - Poor Cover							
Proposed Impervious Percentage (%)	0	AMC	3							
0.102										
Post-Development - Soils Information										
Area ID	Subarea Acreage	Cover Type	Vegetative Cover	Soil A %	Soil B %	Soil C %	Soil D %	RI Index AMC I	RI Index AMC II	RI Index AMC III
1A	2.55 Ac.	Urban Landscaping	Good Cover	100				16	32	52
								0	0	0
								0	0	0
Total= 2.55 Ac.		Weighted Average RI =						16 Ac.	32 Ac.	52.0
Sub Area 2B - Post Condition Summary										
100-year Flowrate =		6.24	cfs							
Tc, Min=		7.98	min							
100yr Peak Intensity (for drainage area) =		3.64	in/hr							
Runoff Coefficient (100-year) =		0.67								

APPENDIX B: HYDRAULIC CALCULATIONS

- Preliminary Storm Drain Hydraulics
- Preliminary Riser Calculations
- Channel A Hydraulics

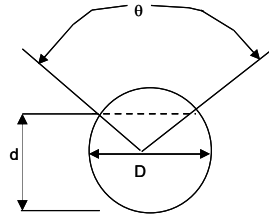
Onsite Storm Drain Capacity Calculations

Project: Akash Winery Expansion Location: Riverside County
By: DSB Date: 6/2/2023
ID: Date: 6/2/2023 mdo version 12.8.00

Clear Data Entry Cells

Mannings Formula

$$Q=(1.486/n)AR_n^{2/3}S^{1/2}$$



$$R=A/P$$

A=cross sectional area

P=wetted perimeter

S=slope of channel

n=Manning's roughness coefficient

$$V=(1.49/n)R_n^{2/3}S^{1/2}$$

$$Q=V \times A$$

Storm Drain ID	Tributary Area	Diameter, D (in)	Depth, d (in)	Mannings n	θ	Slope, S (ft/ft)	Area,ft ²	Wetted Perimeter, ft	Hydraulic Radius, ft	velocity ft/s	SD Capacity, cfs
Ex Line B/Prop. Line B.1	1B & 2A	18	18	0.012	0	0.5%	1.77	4.71	0.38	4.55	8.05
Line 1A	1A	12	12	0.012	0	0.5%	0.79	3.14	0.25	3.47	2.73
Line 2A	1A	12	12	0.012	0	0.5%	0.79	3.14	0.25	3.47	2.73
Line 3A	3A	12	12	0.012	0	0.5%	0.79	3.14	0.25	3.47	2.73
Line 4A	3A	18	18	0.012	0	0.5%	1.77	4.71	0.38	4.55	8.05
Line 5A	3A	12	12	0.012	0	0.5%	0.79	3.14	0.25	3.47	2.73
Line 6A	2B	18	18	0.012	0	0.5%	1.77	4.71	0.38	4.55	8.05

100-Year Flow Riser Analysis

Project: Akash Winery Expansion

By: DSB

Location: 5/5/2023

Date:

Riverside County

Unsubmerged Riser (Weir Analysis)

$Q = C_w(\pi D^3/4)[H-E_o]^{1.5}$

C_w= Weir Coefficient

D = Diameter

H= Water Surface Elevation

E_o= Top of Riser

Submerged Riser (Orifice)

$Q = C_o A_o \sqrt{2g(H-E_o)}$

$R = A/P$

C_o= Orifice Coefficient

A_o= Riser Area Opening

H= Water Surface Elevation

E_o= Top of Riser

Transition Depth (ft)

if $(H-E_o) < 0.5D$, Weir Analysis

if $(H-E_o) > 0.5D$, Orifice Analysis

Legend	
Calculated	
User Input	

ID	Basin Bottom Elevation (ft):	Max Flow Rate (cfs)	Riser Dia. (ft)	Riser Height (ft)	Orifice Coefficient, C _o :	Weir Coefficient, C _w :	Top of Riser Elevation, E _o (ft):	Riser Opening Area (ft ²):	Riser Circumference (ft):	Transition Analysis (0.5*D)	Weir Analysis, Water Surface Elevation (ft)	Transition Analysis (H-E _o)	Note
BMP 1A	0	1.21	1.5	4.7	0.6	3.33	4.7	1.77	4.71	0.75	4.88	0.18	Weir Hydraulic Controls
BMP 2A	0	9.50	1.5	4.7	0.6	3.33	4.7	1.77	4.71	0.75	5.42	0.72	Weir Hydraulic Controls
BMP 3A	0	4.04	1.5	4.7	0.6	3.33	4.7	1.77	4.71	0.75	5.10	0.40	Weir Hydraulic Controls

See to Proposed Condition Hydrology Exhibit

Hydraulic Analysis Report

Project Data

Project Title:
Designer:
Project Date: Friday, June 2, 2023
Project Units: U.S. Customary Units
Notes:

Channel Analysis: Channel A Hydraulics

Notes:

Input Parameters

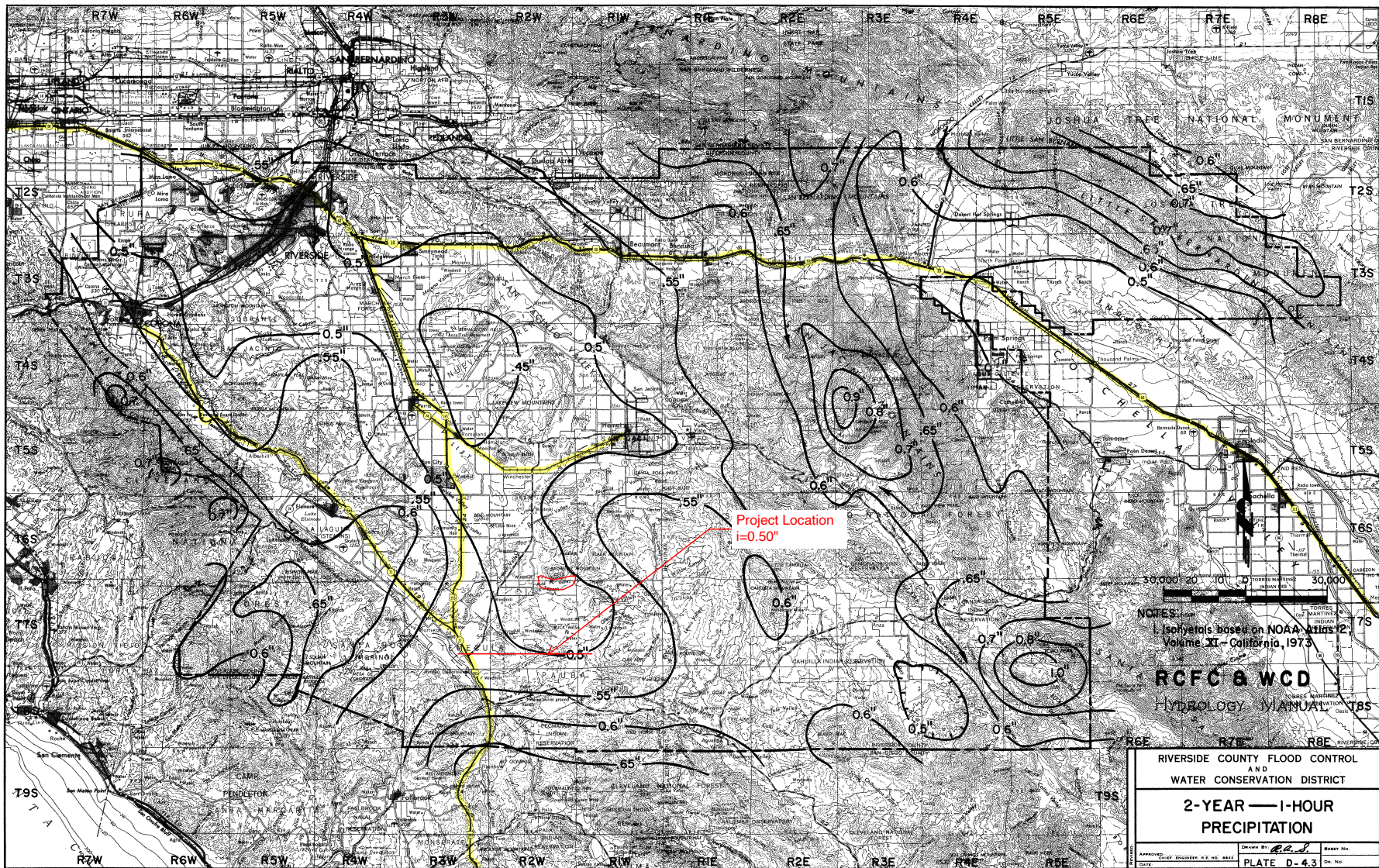
Channel Type: Trapezoidal
Side Slope 1 (Z1): 2.0000 ft/ft
Side Slope 2 (Z2): 2.0000 ft/ft
Channel Width: 0.0010 ft
Longitudinal Slope: 0.0330 ft/ft
Manning's n: 0.0130
Flow: 6.2400 cfs

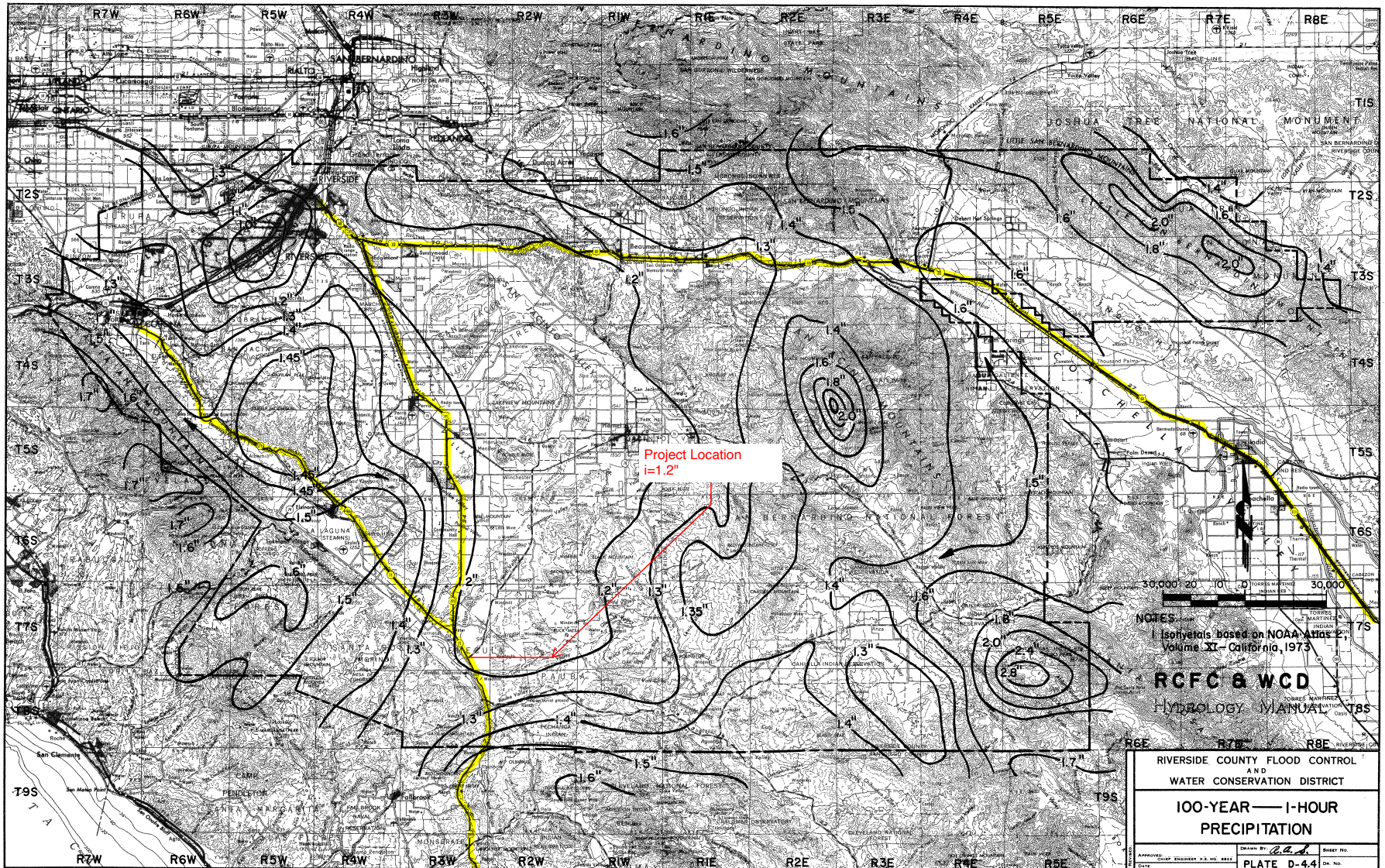
Result Parameters

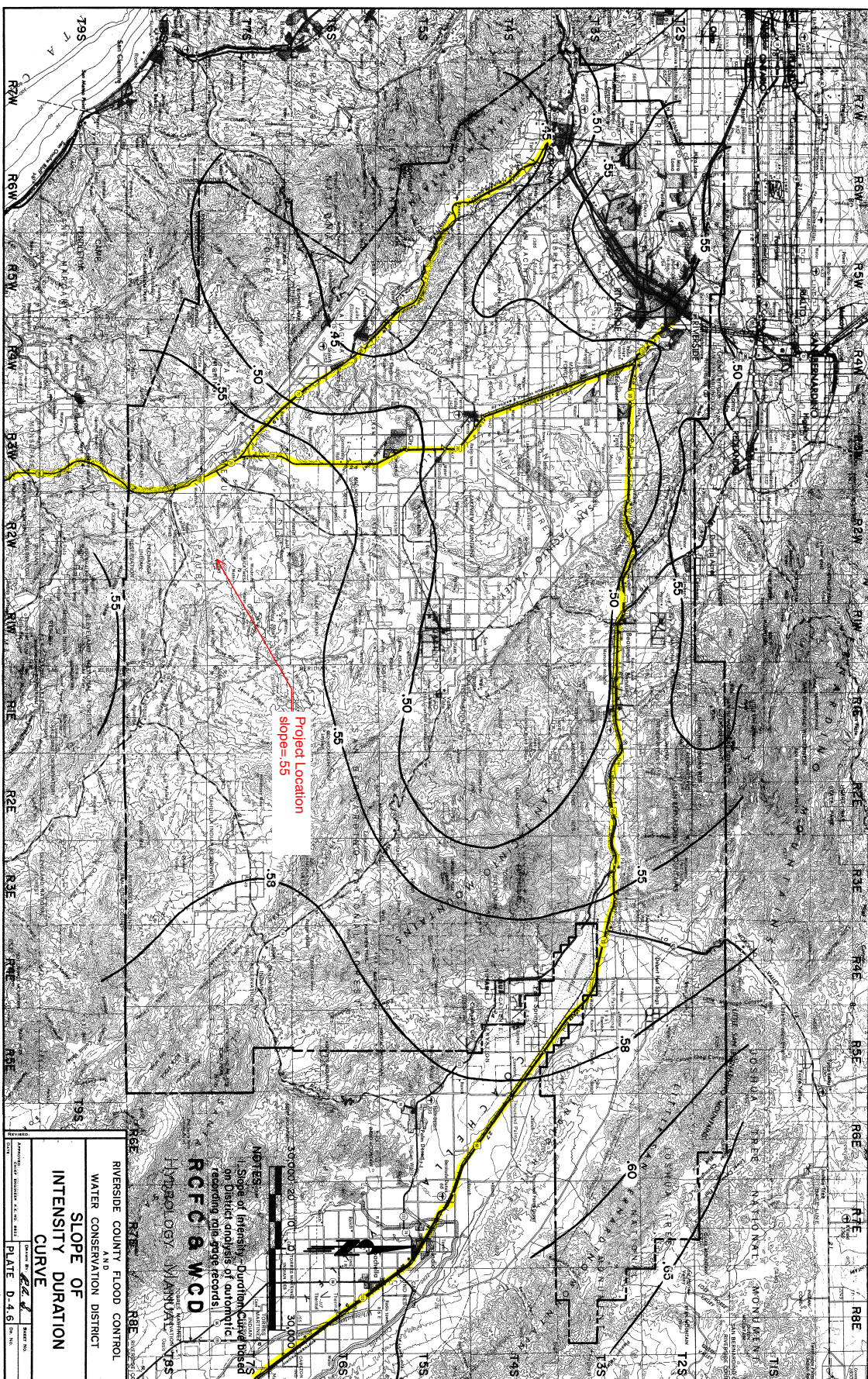
Depth: 0.6002 ft
Area of Flow: 0.7212 ft²
Wetted Perimeter: 2.6854 ft
Hydraulic Radius: 0.2686 ft
Average Velocity: 8.6525 ft/s
Top Width: 2.4020 ft
Froude Number: 2.7827
Critical Depth: 0.9042 ft
Critical Velocity: 3.8141 ft/s
Critical Slope: 0.0037 ft/ft
Critical Top Width: 3.62 ft
Calculated Max Shear Stress: 1.2360 lb/ft²
Calculated Avg Shear Stress: 0.5530 lb/ft²

APPENDIX C: REFERENCE

- Riverside County Excerpt : Plate-5.6
- 2 Year 1 Hour Isohyetal Map
- 100 Year 1 Hour Isohyetal Map
- Plate D-4.6 Slope of Intensity Duration Curve
- Plate D-5.5 Runoff Index for Pervious Areas
- Plate D-3 - Time of Concentration Nomograph
- Plate D-4.7 Intensity-Duration Curves Calculation Sheet
- Precise Grading Plans







RUNOFF INDEX NUMBERS OF HYDROLOGIC SOIL-COVER COMPLEXES FOR PERVIOUS AREAS-AMC II					
Cover Type (3)	Quality of Cover (2)	Soil Group			
		A	B	C	D
<u>NATURAL COVERS</u> -					
Barren (Rockland, eroded and graded land)		78	86	91	93
Chaparrel, Broadleaf (Manzonita, ceanothus and scrub oak)	Poor	53	70	80	85
	Fair	40	63	75	81
	Good	31	57	71	78
Chaparrel, Narrowleaf (Chamise and redshank)	Poor	71	82	88	91
	Fair	55	72	81	86
Grass, Annual or Perennial	Poor	67	78	86	89
	Fair	50	69	79	84
	Good	38	61	74	80
Meadows or Cienegas (Areas with seasonally high water table, principal vegetation is sod forming grass)	Poor	63	77	85	88
	Fair	51	70	80	84
	Good	30	58	72	78
Open Brush (Soft wood shrubs - buckwheat, sage, etc.)	Poor	62	76	84	88
	Fair	46	66	77	83
	Good	41	63	75	81
Woodland (Coniferous or broadleaf trees predominate. Canopy density is at least 50 percent)	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	28	55	70	77
Woodland, Grass (Coniferous or broadleaf trees with canopy density from 20 to 50 percent)	Poor	57	73	82	86
	Fair	44	65	77	82
	Good	33	58	72	79
<u>URBAN COVERS</u> -					
Residential or Commercial Landscaping (Lawn, shrubs, etc.)	Good	32	56	69	75
Turf (Irrigated and mowed grass)	Poor	58	74	83	87
	Fair	44	65	77	82
	Good	33	58	72	79
<u>AGRICULTURAL COVERS</u> -					
Fallow (Land plowed but not tilled or seeded)		76	85	90	92

RCFC & WCD
HYDROLOGY MANUAL

RUNOFF INDEX NUMBERS
FOR
PERVIOUS AREA

RUNOFF INDEX NUMBERS OF HYDROLOGIC SOIL-COVER COMPLEXES FOR PERVIOUS AREAS-AMC II

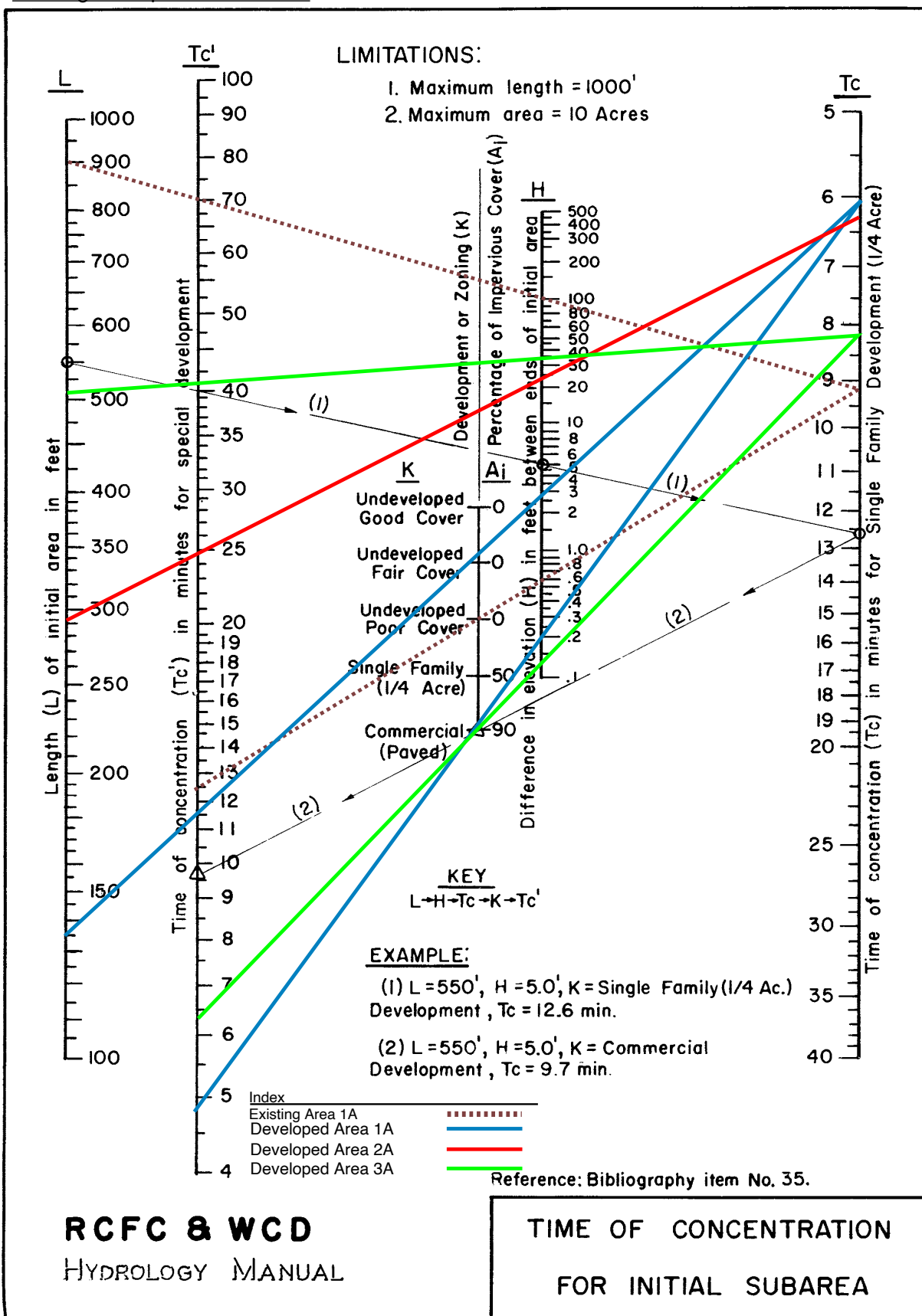
Cover Type (3)	Quality of Cover (2)	Soil Group			
		A	B	C	D
<u>AGRICULTURAL COVERS</u> (cont.) -					
Legumes, Close Seeded (Alfalfa, sweetclover, timothy, etc.)	Poor	66	77	85	89
	Good	58	72	81	85
Orchards, Deciduous (Apples, apricots, pears, walnuts, etc.)		See Note 4			
Orchards, Evergreen (Citrus, avocados, etc.)	Poor	57	73	82	86
	Fair	44	65	77	82
	Good	33	58	72	79
Pasture, Dryland (Annual grasses)	Poor	67	78	86	89
	Fair	50	69	79	84
	Good	38	61	74	80
Pasture, Irrigated (Legumes and perennial grass)	Poor	58	74	83	87
	Fair	44	65	77	82
	Good	33	58	72	79
Row Crops (Field crops - tomatoes, sugar beets, etc.)	Poor	72	81	88	91
	Good	67	78	85	89
Small Grain (Wheat, oats, barley, etc.)	Poor	65	76	84	88
	Good	63	75	83	87
Vineyard		See Note 4			

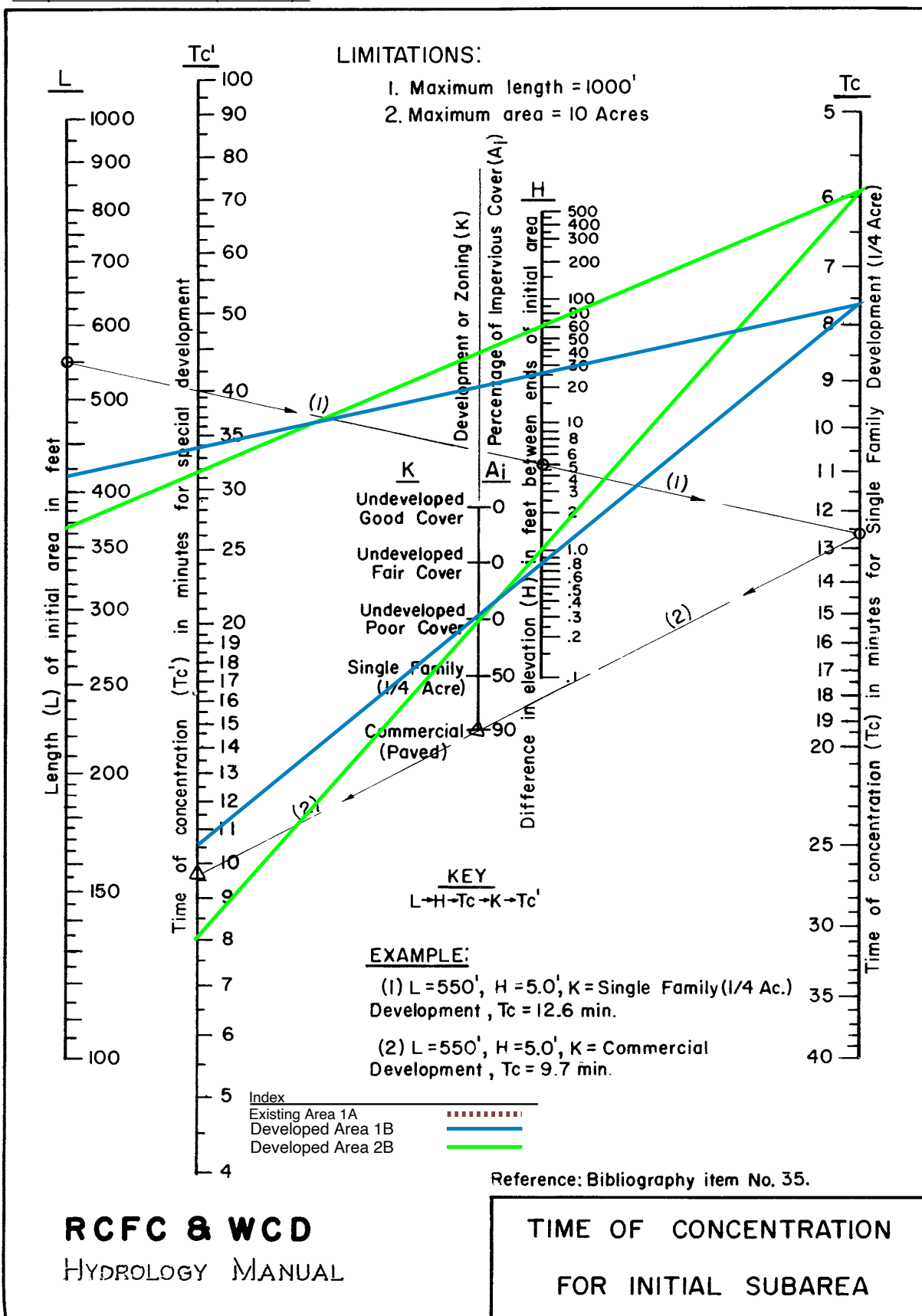
Notes:

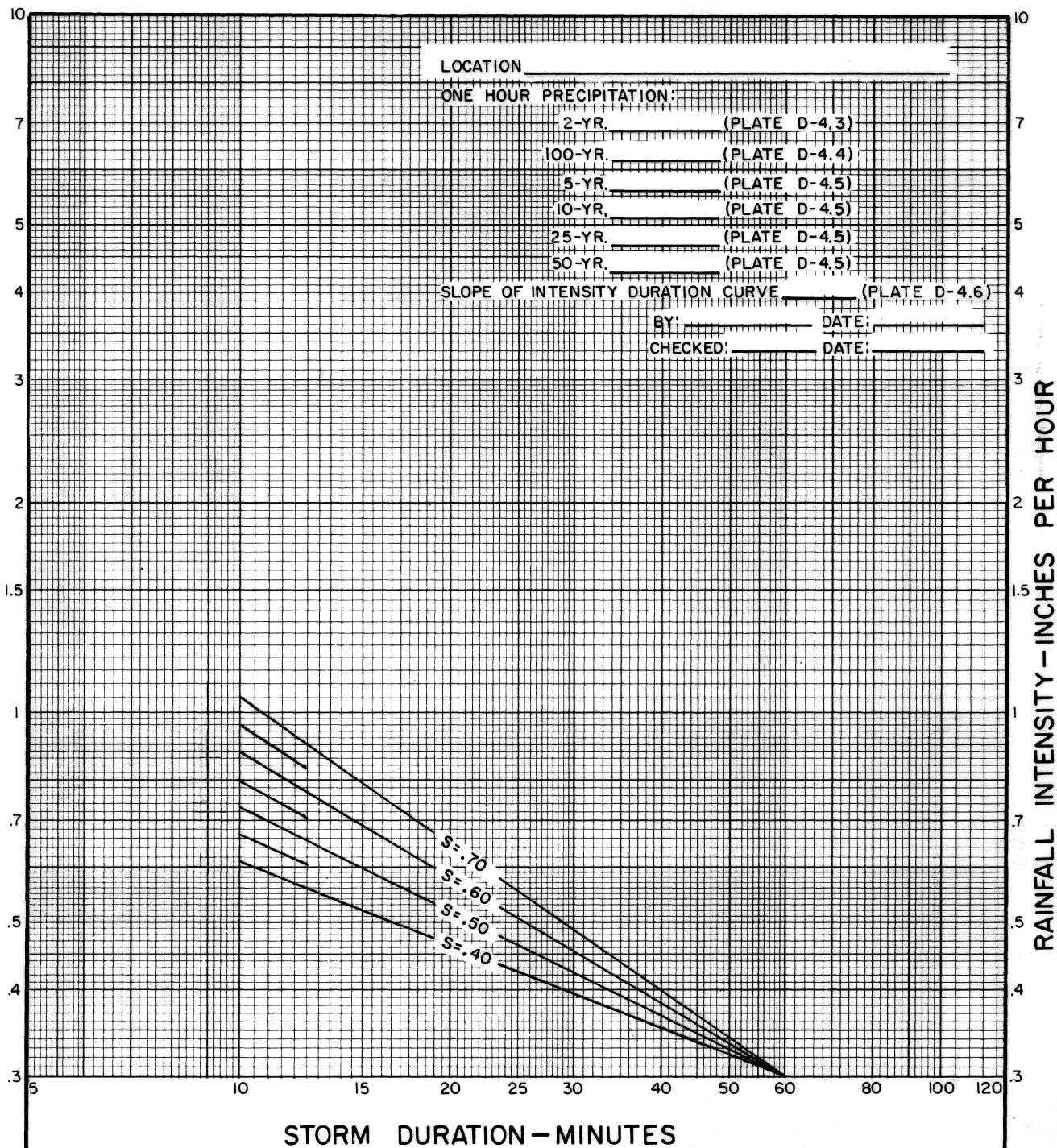
1. All runoff index (RI) numbers are for Antecedent Moisture Condition (AMC) II.
2. Quality of cover definitions:
 Poor-Heavily grazed or regularly burned areas. Less than 50 percent of the ground surface is protected by plant cover or brush and tree canopy.
 Fair-Moderate cover with 50 percent to 75 percent of the ground surface protected.
 Good-Heavy or dense cover with more than 75 percent of the ground surface protected.
3. See Plate C-2 for a detailed description of cover types.
4. Use runoff index numbers based on ground cover type. See discussion under "Cover Type Descriptions" on Plate C-2.
5. Reference Bibliography item 17.

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**RUNOFF INDEX NUMBERS
FOR
PERVIOUS AREA**







RCFC & WCD
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INTENSITY-DURATION
CURVES
CALCULATION SHEET

PLATE D-4.7

RUNOFF COEFFICIENT CURVE DATA

The data in the following tables may be used to develop runoff coefficient (C) curves for any combination of runoff index (RI) number and antecedent moisture condition (AMC). For an RI number with an AMC of II (from Plate D-5.5) enter the tables on the following pages and plot the "C" curve data directly on Plate D-5.8. "C" curve data is given for even RI numbers only, but values may easily be interpolated for odd RI numbers.

For an AMC of I or III enter the tabulation on this page with the RI for AMC II, and read the appropriate RI for AMC I or III. Use this revised RI to enter the tables on the following pages to determine "C". For example if RI = 40 for AMC II, then RI = 22 for AMC I and RI = 60 for AMC III.

AMC ADJUSTMENT RELATIONSHIPS

RI FOR AMC II	RI FOR OTHER AMC CONDITIONS:		RI FOR AMC II	RI FOR OTHER AMC CONDITIONS:	
	AMC I	AMC III		AMC I	AMC III
10	--	22	55	35	74
11	--	24	56	36	75
12	--	25	57	37	75
13	--	27	58	38	76
14	--	28	59	39	77
15	--	30	60	40	78
16	--	31	61	41	78
17	--	33	62	42	79
18	--	34	63	43	80
19	--	36	64	44	81
20	--	37	65	45	82
21	10	38	66	46	82
22	10	39	67	47	83
23	11	41	68	48	84
24	11	42	69	50	84
25	12	43	70	51	85
26	12	44	71	52	86
27	13	46	72	53	86
28	14	47	73	54	87
29	14	49	74	55	88
30	15	50	75	57	88
31	16	51	76	58	89
32	16	52	77	59	89
33	17	53	78	60	90
34	18	54	79	62	91
35	18	55	80	63	91
36	19	56	81	64	92
37	20	57	82	66	92
38	21	58	83	67	93
39	21	59	84	68	93
40	22	60	85	70	94
41	23	61	86	72	94
42	24	62	87	73	95
43	25	63	88	75	95
44	25	64	89	76	96
45	26	65	90	78	96
46	27	66	91	80	97
47	28	67	92	81	97
48	29	68	93	83	98
49	30	69	94	85	98
50	31	70	95	87	98
51	31	70	96	89	99
52	32	71	97	91	99
53	33	72	98	94	99
54	34	73	99	97	--

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**RUNOFF COEFFICIENT
CURVE DATA**

RCFC & WCD HYDROLOGY MANUAL

RUNOFF COEFFICIENTS FOR RI INDEX NO. = 28

IMPERVIOUS PERCENT	INTENSITY - INCHES/HOUR										
	.0	.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0
0.	.00	.11	.20	.27	.33	.38	.42	.45	.48	.53	.57
5.	.04	.15	.24	.31	.36	.41	.44	.48	.51	.55	.59
10.	.09	.19	.27	.34	.39	.43	.47	.50	.53	.57	.61
15.	.13	.23	.31	.37	.42	.46	.49	.52	.55	.59	.62
20.	.18	.27	.34	.40	.45	.48	.52	.54	.57	.61	.64
25.	.22	.31	.38	.43	.47	.51	.54	.57	.59	.63	.65
30.	.27	.35	.41	.46	.50	.54	.56	.59	.61	.64	.67
35.	.31	.39	.45	.49	.53	.56	.59	.61	.63	.66	.69
40.	.36	.43	.48	.52	.56	.59	.61	.63	.65	.68	.70
45.	.40	.47	.52	.56	.59	.61	.64	.66	.67	.70	.72
50.	.45	.51	.55	.59	.62	.64	.66	.68	.69	.72	.74
55.	.49	.55	.59	.62	.64	.67	.68	.70	.71	.74	.75
60.	.54	.59	.62	.65	.67	.69	.71	.72	.73	.75	.77
65.	.58	.63	.66	.68	.70	.72	.73	.74	.75	.77	.79
70.	.63	.66	.69	.71	.73	.74	.76	.77	.78	.79	.80
75.	.67	.70	.73	.74	.76	.77	.78	.79	.80	.81	.82
80.	.72	.74	.76	.77	.79	.80	.80	.81	.82	.83	.83
85.	.76	.78	.80	.81	.81	.82	.83	.83	.84	.85	.85
90.	.81	.82	.83	.84	.84	.85	.85	.86	.86	.86	.87
95.	.86	.86	.87	.87	.87	.87	.88	.88	.88	.88	.88
100.	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90

RUNOFF COEFFICIENTS FOR RI INDEX NO. = 30

IMPERVIOUS PERCENT	INTENSITY - INCHES/HOUR										
	.0	.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0
0.	.00	.12	.22	.29	.35	.40	.44	.48	.51	.55	.59
5.	.04	.16	.25	.32	.38	.43	.46	.50	.53	.57	.61
10.	.09	.20	.29	.35	.41	.45	.49	.52	.55	.59	.62
15.	.13	.24	.32	.38	.43	.48	.51	.54	.57	.61	.64
20.	.18	.28	.36	.41	.46	.50	.53	.56	.59	.62	.65
25.	.22	.32	.39	.44	.49	.53	.56	.58	.60	.64	.67
30.	.27	.36	.42	.47	.52	.55	.58	.60	.62	.66	.68
35.	.31	.40	.46	.51	.54	.58	.60	.62	.64	.68	.70
40.	.36	.43	.49	.54	.57	.60	.63	.65	.66	.69	.72
45.	.40	.47	.53	.57	.60	.63	.65	.67	.68	.71	.73
50.	.45	.51	.56	.60	.63	.65	.67	.69	.70	.73	.75
55.	.49	.55	.59	.63	.65	.68	.69	.71	.72	.74	.76
60.	.54	.59	.63	.66	.68	.70	.72	.73	.74	.76	.78
65.	.58	.63	.66	.69	.71	.73	.74	.75	.76	.78	.79
70.	.63	.67	.70	.72	.74	.75	.76	.77	.78	.80	.81
75.	.67	.71	.73	.75	.76	.78	.79	.79	.80	.81	.82
80.	.72	.74	.76	.78	.79	.80	.81	.82	.82	.83	.84
85.	.76	.78	.80	.81	.82	.83	.83	.84	.84	.85	.85
90.	.81	.82	.83	.84	.85	.85	.85	.86	.86	.87	.87
95.	.86	.86	.87	.87	.87	.88	.88	.88	.88	.88	.88
100.	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90

RUNOFF COEFFICIENTS FOR RI INDEX NO. = 32

IMPERVIOUS PERCENT	INTENSITY - INCHES/HOUR										
	.0	.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0
0.	.00	.13	.23	.31	.37	.42	.46	.50	.53	.57	.61
5.	.04	.17	.27	.34	.40	.45	.48	.52	.55	.59	.63
10.	.09	.21	.30	.37	.43	.47	.51	.54	.56	.61	.64
15.	.13	.25	.33	.40	.45	.49	.53	.56	.58	.62	.65
20.	.18	.29	.37	.43	.48	.52	.55	.58	.60	.64	.67
25.	.22	.33	.40	.46	.50	.54	.57	.60	.62	.66	.68
30.	.27	.36	.43	.49	.53	.57	.59	.62	.64	.67	.70
35.	.31	.40	.47	.52	.56	.59	.62	.64	.66	.69	.71
40.	.36	.44	.50	.55	.58	.61	.64	.66	.68	.70	.73
45.	.40	.48	.53	.58	.61	.64	.66	.68	.69	.72	.74
50.	.45	.52	.57	.61	.64	.66	.68	.70	.71	.74	.76
55.	.49	.56	.60	.64	.66	.68	.70	.72	.73	.75	.77
60.	.54	.59	.63	.66	.69	.71	.73	.74	.75	.77	.78
65.	.58	.63	.67	.69	.72	.73	.75	.76	.77	.79	.80
70.	.63	.67	.70	.72	.74	.76	.77	.78	.79	.80	.81
75.	.67	.71	.73	.75	.77	.78	.79	.80	.81	.82	.83
80.	.72	.75	.77	.78	.79	.80	.81	.82	.83	.83	.84
85.	.76	.79	.80	.81	.82	.83	.83	.84	.84	.85	.86
90.	.81	.82	.83	.84	.85	.85	.86	.86	.86	.87	.87
95.	.86	.86	.87	.87	.87	.88	.88	.88	.88	.88	.89
100.	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90

RUNOFF COEFFICIENTS FOR RI INDEX NO. = 34

IMPERVIOUS PERCENT	INTENSITY - INCHES/HOUR										
	.0	.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0
0.	.00	.15	.25	.33	.39	.44	.48	.52	.55	.59	.63
5.	.04	.18	.28	.36	.42	.47	.50	.54	.56	.61	.64
10.	.09	.22	.32	.39	.44	.49	.52	.56	.58	.62	.66
15.	.13	.26	.35	.42	.47	.51	.55	.57	.60	.64	.67
20.	.18	.30	.38	.44	.49	.53	.57	.59	.62	.65	.68
25.	.22	.33	.41	.47	.52	.56	.59	.61	.63	.67	.70
30.	.27	.37	.45	.50	.54	.58	.61	.63	.65	.69	.71
35.	.31	.41	.48	.53	.57	.60	.63	.65	.67	.70	.72
40.	.36	.45	.51	.56	.60	.63	.65	.67	.69	.72	.74
45.	.40	.49	.54	.59	.62	.65	.67	.69	.71	.73	.75
50.	.45	.52	.58	.62	.65	.67	.69	.71	.72	.75	.76
55.	.49	.56	.61	.64	.67	.69	.71	.73	.74	.76	.78
60.	.54	.60	.64	.67	.70	.72	.73	.75	.76	.78	.79
65.	.58	.64	.67	.70	.72	.74	.75	.77	.78	.79	.81
70.	.63	.67	.71	.73	.75	.76	.77	.79	.79	.81	.82
75.	.67	.71	.74	.76	.77	.79	.80	.80	.81	.82	.83
80.	.72	.75	.77	.79	.80	.81	.82	.82	.83	.84	.85
85.	.76	.79	.80	.81	.82	.83	.83	.84	.84	.85	.86
90.	.81	.82	.84	.84	.85	.85	.86	.86	.86	.87	.87
95.	.86	.86	.87	.87	.87	.88	.88	.88	.88	.88	.89
100.	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90

RUNOFF COEFFICIENT CURVE DATA

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RUNOFF COEFFICIENTS FOR RI INDEX NO. = 60

IMPERVIOUS PERCENT	INTENSITY - INCHES/HOUR											
	.0	.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	
0.	.00	.32	.48	.57	.62	.66	.69	.72	.74	.76	.78	
5.	.04	.35	.50	.58	.64	.68	.70	.73	.74	.77	.79	
10.	.09	.38	.52	.60	.65	.69	.71	.74	.75	.78	.80	
15.	.13	.41	.54	.62	.66	.70	.73	.75	.76	.78	.80	
20.	.18	.44	.56	.63	.68	.71	.74	.75	.77	.79	.81	
25.	.22	.47	.58	.65	.69	.72	.75	.76	.78	.80	.81	
30.	.27	.50	.60	.67	.71	.73	.76	.77	.79	.80	.82	
35.	.31	.53	.62	.68	.72	.75	.77	.78	.79	.81	.82	
40.	.36	.55	.65	.70	.73	.76	.78	.79	.80	.82	.83	
45.	.40	.58	.67	.72	.75	.77	.79	.80	.81	.83	.84	
50.	.45	.61	.69	.73	.76	.78	.80	.81	.82	.83	.84	
55.	.49	.64	.71	.75	.78	.79	.81	.82	.83	.84	.85	
60.	.54	.67	.73	.77	.79	.81	.82	.83	.83	.85	.85	
65.	.58	.70	.75	.78	.80	.82	.83	.84	.84	.85	.86	
70.	.63	.73	.77	.80	.82	.83	.84	.85	.85	.86	.87	
75.	.67	.76	.79	.82	.83	.84	.85	.85	.86	.87	.87	
80.	.72	.78	.82	.83	.84	.85	.86	.86	.87	.87	.88	
85.	.76	.81	.84	.85	.86	.86	.87	.87	.88	.88	.88	
90.	.81	.84	.86	.87	.87	.88	.88	.88	.88	.89	.89	
95.	.86	.87	.88	.88	.89	.89	.89	.89	.89	.89	.89	
100.	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90	

RUNOFF COEFFICIENTS FOR RI INDEX NO. = 62

IMPERVIOUS PERCENT	INTENSITY - INCHES/HOUR											
	.0	.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	
0.	.00	.34	.50	.58	.64	.68	.71	.73	.75	.77	.79	
5.	.04	.37	.52	.60	.65	.69	.72	.74	.75	.78	.80	
10.	.09	.40	.54	.61	.67	.70	.73	.75	.76	.79	.80	
15.	.13	.43	.56	.63	.68	.71	.74	.76	.77	.79	.81	
20.	.18	.45	.58	.65	.69	.72	.75	.76	.78	.80	.81	
25.	.22	.48	.60	.66	.70	.73	.76	.77	.79	.81	.82	
30.	.27	.51	.62	.68	.72	.74	.77	.78	.79	.81	.82	
35.	.31	.54	.64	.69	.73	.76	.77	.79	.80	.82	.83	
40.	.36	.56	.66	.71	.74	.77	.78	.80	.81	.82	.84	
45.	.40	.59	.68	.73	.76	.78	.79	.81	.82	.83	.84	
50.	.45	.62	.70	.74	.77	.79	.80	.81	.82	.84	.85	
55.	.49	.65	.72	.76	.78	.80	.81	.82	.83	.84	.85	
60.	.54	.68	.74	.77	.80	.81	.82	.83	.84	.85	.86	
65.	.58	.70	.76	.79	.81	.82	.83	.84	.85	.86	.86	
70.	.63	.73	.78	.80	.82	.83	.84	.85	.85	.86	.87	
75.	.67	.76	.80	.82	.83	.84	.85	.86	.86	.87	.87	
80.	.72	.79	.82	.84	.85	.86	.86	.87	.87	.87	.88	
85.	.76	.82	.84	.85	.86	.87	.87	.87	.87	.88	.88	
90.	.81	.84	.86	.87	.87	.88	.88	.88	.88	.89	.89	
95.	.86	.87	.88	.88	.89	.89	.89	.89	.89	.89	.89	
100.	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90	

RUNOFF COEFFICIENTS FOR RI INDEX NO. = 64

IMPERVIOUS PERCENT	INTENSITY - INCHES/HOUR											
	.0	.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	
0.	.00	.36	.51	.60	.65	.69	.72	.74	.76	.78	.80	
5.	.04	.39	.53	.61	.67	.70	.73	.75	.76	.79	.80	
10.	.09	.41	.55	.63	.68	.71	.74	.76	.77	.79	.81	
15.	.13	.44	.57	.64	.69	.72	.75	.76	.78	.80	.81	
20.	.18	.47	.59	.66	.70	.73	.76	.77	.79	.81	.82	
25.	.22	.50	.61	.67	.72	.74	.76	.78	.79	.81	.82	
30.	.27	.52	.63	.69	.73	.75	.77	.79	.80	.82	.83	
35.	.31	.55	.65	.70	.74	.76	.78	.80	.81	.82	.83	
40.	.36	.58	.67	.72	.75	.78	.79	.80	.81	.83	.84	
45.	.40	.60	.69	.74	.76	.79	.80	.81	.82	.84	.85	
50.	.45	.63	.71	.75	.78	.80	.81	.82	.83	.84	.85	
55.	.49	.66	.73	.76	.79	.81	.82	.83	.84	.85	.86	
60.	.54	.68	.75	.78	.80	.82	.83	.84	.84	.85	.86	
65.	.58	.71	.76	.79	.81	.83	.84	.84	.85	.86	.86	
70.	.63	.74	.78	.81	.83	.84	.85	.85	.86	.86	.87	
75.	.67	.76	.80	.82	.84	.85	.86	.86	.86	.87	.88	
80.	.72	.79	.82	.84	.85	.86	.86	.87	.87	.88	.88	
85.	.76	.82	.84	.86	.86	.87	.87	.88	.88	.88	.88	
90.	.81	.85	.86	.87	.88	.88	.88	.88	.89	.89	.89	
95.	.86	.87	.88	.88	.89	.89	.89	.89	.89	.89	.89	
100.	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90	

RUNOFF COEFFICIENTS FOR RI INDEX NO. = 66

IMPERVIOUS PERCENT	INTENSITY - INCHES/HOUR											
	.0	.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	
0.	.00	.38	.53	.62	.67	.71	.73	.75	.77	.79	.81	
5.	.04	.41	.55	.63	.68	.72	.74	.76	.77	.80	.81	
10.	.09	.43	.57	.65	.69	.73	.75	.77	.78	.80	.82	
15.	.13	.46	.59	.66	.70	.74	.76	.77	.79	.81	.82	
20.	.18	.48	.61	.67	.72	.74	.77	.78	.79	.81	.83	
25.	.22	.51	.63	.69	.73	.75	.77	.79	.80	.82	.83	
30.	.27	.54	.64	.70	.74	.76	.78	.80	.81	.82	.84	
35.	.31	.56	.66	.72	.75	.77	.79	.80	.81	.83	.84	
40.	.36	.59	.68	.73	.76	.78	.80	.81	.82	.83	.84	
45.	.40	.61	.70	.74	.77	.79	.81	.82	.83	.84	.85	
50.	.45	.64	.72	.76	.78	.80	.82	.83	.83	.85	.85	
55.	.49	.67	.74	.77	.80	.81	.82	.83	.84	.85	.86	
60.	.54	.69	.75	.79	.81	.82	.83	.84	.85	.86	.86	
65.	.58	.72	.77	.80	.82	.83	.84	.85	.85	.86	.87	
70.	.63	.74	.79	.82	.83	.84	.85	.86	.86	.87	.87	
75.	.67	.77	.81	.83	.84	.85	.86	.86	.86	.87	.88	
80.	.72	.80	.83	.84	.85	.86	.87	.87	.87	.88	.88	
85.	.76	.82	.85	.86	.87	.87	.87	.88	.88	.88	.89	
90.	.81	.85	.86	.87	.88	.88	.88	.88	.89	.89	.89	
95.	.86	.87	.88	.88	.89	.89	.89	.89	.89	.89	.89	
100.	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90	

RUNOFF COEFFICIENT CURVE DATA

MAP POCKET: EXISTING CONDITIONS EXHIBITS

- o Existing Condition Hydrology Exhibit for Rational Method Study

MAP POCKET: PROPOSED CONDITIONS EXHIBITS

- o Proposed Condition Hydrology Exhibit for Rational Method Study

30 0 30 60
feet
1" = 30'

